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Optical recording/reproducing equipment and method for testing track erroı signal

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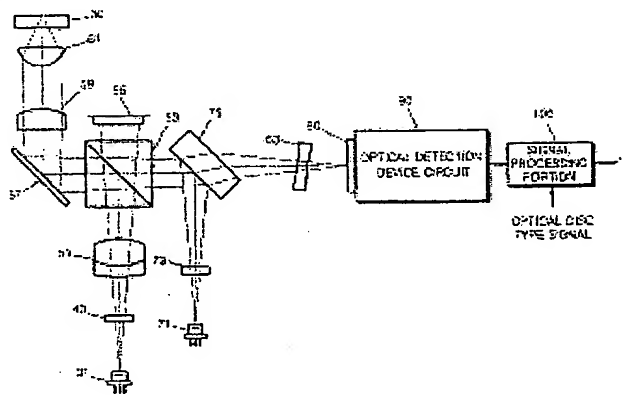
An optical recording/reproducing apparatus includes an optical pickup and a signal processor. The optical pickup includes an optical splitting device which splits light emitted from a first light source into a main light beam and sub-light beams which are symmetrical with respect to the main light beam and irradiates the split light beams on a recording medium, and a light detection device which receives the main light beam and the sub-light beams reflected by the recording medium, so as to detect a tracking error signal in a three-beam method and one of a push-pull method and an improved push-pull method. The signal processor receives the detection signals output by the light detection device and detects the tracking error signal in the three-beam method and one of the push-pull method and the improved push-pull method, and otherwise selectively detects the tracking error signal in one of the three-beam method, the push-pull method and the improved push-pull method, so as to realize an optimal tracking servo-control. Since a selective use of one of the improved push-pull method, the push-pull method and the three-beam method can be made according to the type of an optical disc, the optimal tracking servo-control can be realized regardless of the depth of a pit in an optical disc during a reproduction of data from the optical disc, such as a non-rewritable optical disc.



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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Application No. 2001-9275, filed Feb. 23, 2001, in the Korean Industrial Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an optical recording/reproducing apparatus which realizes an optimal tracking servo-control according to the type of a recording medium such as an optical disc, and a method of detecting a tracking error signal.

[0004] 2. Description of the Related Art

[0005] In general, a reproducing apparatus performs a tracking servo-control in a three-beam method, and a recording apparatus performs a tracking servo-control in a push-pull method, in particular, in a differential push-pull (DPP) method which is an improved push-pull method. Both the three-beam method and the DPP method utilize beams diffracted to the 0<th >and +-1<st >orders by a grating.

[0006] In a reproducing apparatus using the three-beam method, a grating in which the ratio in effectiveness of diffraction between the 0<th >and +-1<st >order beams is about 4:1 through 5:1. That is, the ratio of (0<th >order:+-1<st >order)=(4:1) through (5:1) is adopted according to the intensity of a beam during a reproduction. The difference in phase between the +-1<st >order beam and -1<st >order beam irradiated on an optical disc is set to be 180[deg.].

[0007] FIG. 1 shows a six-section photodetector 10 of a conventional reproducing apparatus. The six-section photodetector 10 includes a main photodetector 11 having a four-section structure and a pair of sub-photodetector 13 and 15 arranged at corresponding sides of the main photodetector 11. The tracking servo-control is realized in the three-beam method by detecting three beams diffracted by a grating. Here, a tracking error signal detected in the three-beam method is a differential signal between detection signals of the sub-photodetectors 13 and 15.

[0008] In a recording apparatus using the DPP method, a grating in which the ratio in effectiveness of diffraction between the 0<th >and +-1<st >order beams of about 10:1 through 15:1 is adopted to increase the efficiency of the 0<th >order beam used for a recording. The difference in phase between the +1<st >order beam and -1<st >order beam irradiated on an optical disc is set to be 360[deg.].

[0009] FIG. 2 shows an eight-section photodetector 20 of a conventional recording apparatus. The eight-section photodetector 20 includes a main photodetector 21 having a four-section structure and a pair of two-section sub-photodetector 23 and 25 arranged at corresponding sides of the main photodetector 21. The tracking servo-control is realized in the DPP method by detecting three beams diffracted by a grating. Here, a tracking error signal detected in the DPP method is the difference between a sum signal of detection signals of sections I1 and J1 of the sub-photodetectors 23 and 25 and a sum signal of detection signals of sections I2 and J2 of the sub-photodetectors 23 and 25.

[0010] The tracking error signals detected in the three-beam method and the DPP method have a different magnitude according to the depth of a pit in an optical disc. FIG. 3 shows that the magnitude of a tracking error signal (TES3-BEAM) in the three-beam method becomes maximum as the depth of a pit of an optical disc is [lambda]/4. In contrast, the magnitude of a tracking error signal (TESDPP) in the DPP method becomes maximum as the depth of a pit of an optical disc is [lambda]/8, while the magnitude becomes minimum as the depth of a pit of an optical disc is [lambda]/4.

[0011] Therefore, the depth of a pit of an optical disc is standardized to an intermediate value, for example [lambda]/5, so as to realize the tracking servo-control for any one of the above servo-control methods adopted.

[0012] However, many of the optical discs currently being sold are manufactured so as to have a pit depth of closer to [lambda]/4 which is deeper than the standardized size. As data is reproduced from an optical disc having deeper pits than the standardized size, the magnitude of a tracking error signal detected by a reproducing apparatus using the three-beam method is large whereas the magnitude of a tracking error signal detected by a reproducing apparatus using the DPP method is close to 0. Accordingly, the tracking servo-control itself becomes impossible.

SUMMARY OF THE INVENTION

[0013] Accordingly, it is an object of the present invention to provide an optical recording/reproducing apparatus, and a method of detecting a tracking error signal, which can realize an optimal tracking servo-control regardless of the depth of a pit during a reproduction of data from an optical disc including a non-rewritable optical disc, by changing a tracking servo-control method according to the type of the optical

disc.
[0014] Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.
[0015] To achieve the above and other objects of the present invention, there is provided an optical recording/reproducing apparatus comprising an optical pickup and a signal processor. The optical pickup includes an optical splitting device which splits light emitted from a first light source into a main light beam and at least two sub-light beams which are symmetrical with respect to the main light beam and irradiates the split light beams on a recording medium, and a light detection device which receives the main light beam and the sub-light beams reflected by the recording medium, so as to detect a tracking error signal in a three-beam method and in one of a push-pull method and an improved push-pull method. The signal processor receives detection signals output by the light detection device and detects the tracking error signal in the three-beam method and in one of the push-pull method and the improved push-pull method, and otherwise detects the tracking error signal by selectively using one of the three-beam method, the push-pull method, and the improved push-pull method, so as to realize an optimal tracking servo-control.
[0016] According to an aspect of the present invention, the tracking servo-control is realized by using the tracking error signal in the three-beam method where the recording medium comprises a predetermined reproduction only recording medium, and using the tracking error signal in one of the push-pull method and the improved push-pull method where the recording medium comprises a predetermined recording medium which can be recorded on at least once, according to a recording medium type signal detected by the optical recording/reproducing apparatus.
[0017] According to another aspect of the present invention, the optical splitting device splits the light emitted from the first light source into the main light beam and at least four sub-light beams which are symmetrical with respect to the main light beam, and the signal processor comprises a first detection portion which detects the tracking error signal in the three-beam method from first detection signals with respect to two sub-light beams which are closest to the main light beam, and a second detection portion which detects the tracking error signal in the improved push-pull method from second detection signals with respect to other two sub-light beams and main detection signals with respect to the main light beam.
[0018] According to yet another aspect of the present invention, the signal processor further comprises a switch which is installed one of between the light detection device and the first and second detection portions, and at output terminals of the first and second detection portions, and a controller which controls the switch by using the recording medium type signal so as to detect the tracking error signal with one of the first and second detection portions.
[0019] According to still another aspect of the present invention, the light detection device comprises a main photodetector which detects the main light beam, first sub-photodetectors which receive corresponding ones of the two sub-light beams which are closest to the main light beam, and second sub-photodetectors which receive corresponding ones of the other two sub-light beams which are farther away from the main light beam than the two sub-light beams.
[0020] According to still yet another aspect of the present invention, the main photodetector comprises a structure having at least two sections and each of the second sub-photodetectors comprises a structure having one of two and four sections.
[0021] According to an additional aspect of the present invention, the optical recording/reproducing apparatus further comprises a light detection device circuit including a current-to-voltage converting unit which converts a current signal output from the main photodetector and the first and second sub-photodetectors into a voltage signal and outputs the converted voltage signal, and a switch which selectively outputs each of the detection signals from a corresponding one the first and second sub-photodetectors.
[0022] According to yet additional aspect of the present invention, the optical splitting device comprises a diffracting device which diffracts the light emitted from the light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.
[0023] According to still additional aspect of the present invention, the diffracting device performs diffraction so as to have a diffraction ratio between the 0<th >order, the +-1<st >order, and the +-2<nd >order diffracted light beams that is substantially 8-16:0.3-2.3:0.3-2.3, and a total diffraction efficiency of the 0<th >order, the +-1<st >order, and the +-2<nd >order diffracted light beams with respect to an incident light beam of at least 70%.
[0024] According to still yet additional aspect of the present invention, the optical splitting device splits the light beam emitted from the first light source into the main light beam and at least two sub-light beams which are symmetrical with respect to the main light beam, and the signal processor comprises a first detection portion which detects the tracking error signal in the push-pull method by using first detection signals with respect to the main light beam, and a second detection portion which detects the tracking error signal in the three-beam method by using second detection signals with respect to two sub-light beams which are symmetrical with respect to the main light beam.
[0025] According to another additional aspect of the present invention, the signal processor further comprises a switch installed at output terminals of the first and second detection portions, and a controller which control the switch by using the recording medium type signal so as to selectively output the tracking error signal from one of the first and second detection portions.

[0026] According to a further aspect of the present invention, the light detection device comprises a main photodetector which detects the main light beam and sub-photodetectors which receives corresponding ones of the two sub-light beams, wherein the main photodetector comprises a structure having at least two sections.
[0027] To achieve the above and other objects of the present invention, there is provided a method of detecting a tracking error signal in an optical recording/reproducing apparatus, the method comprising splitting light emitted from a light source into a main light beam and at least two sub-light beams which are symmetrical with respect to the main light beam and having the split light beams irradiated on a recording medium, detecting the main light beam and the sub-light beams reflected by the recording medium, and detecting the tracking error signal by using detection signals of the main light beam and/or the sub-light beams in a three-beam method and one of a push-pull method and an improved push-pull method, and otherwise in one of the three-beam method, the push-pull method, and the improved push-pull method.
[0028] According to still another additional aspect of the present invention, the detecting of the tracking error signal comprises selecting a tracking servo-control method including one of the three-beam method, the push-pull method and the improved push-pull method according to a recording medium type signal detected by the optical recording/reproducing apparatus, and detecting the tracking error signal according to the selected servo-control method.
[0029] According to yet another additional aspect of the present invention, the detecting of the tracking error signal comprises using the recording medium type signal detected by the optical recording/reproducing apparatus, and detecting the tracking error signal in the three-beam method where the recording medium comprises a predetermined reproduction only recording medium, and in one of the push-pull method and the improved push-pull method where the recording medium comprises a predetermined recording medium which can be recorded on at least once.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The above and other objects and advantages of the present invention will become more apparent and more readily appreciated by describing in detail preferred embodiments thereof with reference to the accompanying drawings in which:
[0031] FIG. 1 is a plan view showing a six-section photodetector adopted in a conventional reproducing apparatus;
[0032] FIG. 2 is a plan view showing a eight-section photodetector adopted in the conventional recording apparatus;
[0033] FIG. 3 is a graph of a tracking error signal with respect to the depth of a pit of an optical disc according to the three-beam method of FIG. 1 and the improved push-pull method of FIG. 2;
[0034] FIG. 4 is a view schematically showing the structure of an optical recording/reproducing apparatus system according to the present invention;
[0035] FIG. 5 is a view schematically showing diffracted beams irradiated on the optical disc of FIG. 4;
[0036] FIG. 6 is a view showing a photodetector device adopted in an optical recording/reproducing apparatus according to an embodiment of the present invention;
[0037] FIG. 7 is a circuit diagram for realizing an optimal tracking servo-control adopted in the optical recording/reproducing apparatus according to embodiment of the present invention shown in FIG. 6;
[0038] FIG. 8 is a view showing a photodetector device adopted in an optical recording/reproducing apparatus according to another embodiment of the present invention; and
[0039] FIG. 9 is a circuit diagram for realizing the optimal tracking servo-control adopted in the optical recording/reproducing apparatus according to embodiment of the present invention shown in FIG. 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0040] Reference will now be made in detail to the present preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.
[0041] The present invention is characterized in that a tracking servo-control is performed in a three beam method where an optical disc for reproduction such as a CD-ROM is inserted and in one of a push-pull method and an improved push-pull method as an optical disc for recording such as a CD-R/RW and/or DVD-RAM is inserted, by using a feature where the type of an optical disc is discriminated where the optical disc is first inserted into an optical recording/reproducing apparatus of the present invention. By adopting the above-mentioned invention, an optical pickup for a recording apparatus can stably realize the tracking servo-control regardless of the depth of a pit of an optical disc for reproduction.
[0042] FIG. 4 shows an example of an optical recording/reproducing apparatus system according to the present invention. The optical recording/reproducing apparatus includes a signal processor 100 and an optical pickup which irradiates a main light beam to a main track of an optical disc 30 and at least four sub-light beams symmetrical with respect to the main light beam. The optical pick up also receives and detects the main and sub-light beams reflected by the optical disc 30. The signal processor 100 selectively detects a tracking error signal in one of an improved push-pull method and a three-beam method by using

detection signals of the main light beam and the sub-light beams.
[0043] The optical pickup includes a first light source 31, an optical splitting device 40 which splits a light beam emitted from the first light source 31 into the main light beam and at least four sub-light beams which are symmetrical with respect to the main light beam, an optical system which guides the light beams split by the optical splitting device 40 to land on the optical disc 30, and a light detection device 80 which receives the main light beam and the sub-light beams reflected by the optical disc 30.
[0044] A diffraction device, for example, a grating, which splits the light beam emitted from the first light source 31 into at least five light beams by diffracting the light beam emitted from the first light source 31 into 0<th >order, +-1<st >order, the +-2<nd >order, etc., light beams, is provided as the optical splitting device 40. Here, the 0<th >order light beam becomes the main light beam, the +-1<st >order light beams become two first sub-light beams relatively close to the main light beam, and the +-2<nd >order light beams become two second sub-light beams relatively far from the main light beam.
[0045] According to an aspect of the present invention, a holographic device may be provided as the optical splitting device 40.
[0046] The optical splitting device 40 diffracts the light beam emitted from the first light source 31 into the 0<th >order light beam, the +-1<st >order light beams, and the +-2<nd >order light beams at a diffraction ratio of about 8-16:0.3-2.3:0.3-2.3, so as to achieve the total efficiency of diffraction into the 0<th >order light beam, the +-1<st >order light beams, and the +-2<nd >order light beams with respect to the incident light beam of at least 70%.
[0047] According to another aspect of the present invention, the optical splitting device 40 diffracts the light beam emitted from the light source 31 into the 0<th >order, +-1st order, and +-2nd order light beams at a diffraction ratio of about 14:0.5:1, so as to achieve the total efficiency of diffraction into the 0<th >order, +-1st order and +-2nd order light beams with respect to the incident light beam of at least 90%.
[0048] FIG. 5 shows the diffracted light beams irradiated on the optical disc 30. The pitch of the optical splitting device 40 and the structure of the optical system are arranged so as to diffract the light beams on a surface of the optical disc 30 as shown in FIG. 5. A difference in phase of 180[deg.] is generated between the +-1<st >order beam and the -1<st >order beam and a difference in phase of 360[deg.] is generated between the +2<nd >order beam and -2<nd >order beam as the light beam diffracted by the optical splitting device 40 is irradiated onto the optical disc 30. Accordingly, with the above phase differences, the +-2<nd >order beams can be used to detect a tracking error signal in the improved push-pull method while the +-1<st >order beams can be used to detect a tracking error signal in the three-beam method. Therefore, a tracking servo-control method can be selectively changed.
[0049] FIG. 6 shows a light detection device 80 adopted in an optical recording/reproducing apparatus according to an embodiment of the present invention. The light detection device 80 performs an optimal tracking servo-control according to the depth of a pit formed in the optical disc 30 by detecting the above diffracted beams. The light detection device 80 includes a main photodetector 81 which receives the 0<th >order beam, first sub-photodetectors 83 and 85 which receive corresponding ones of the +-1<st >order beams, and second sub-photodetectors 87 and 89 which receive corresponding ones of the +-2<nd >order beams.
[0050] According to yet another aspect of the present invention, the main photodetector 81 comprises at least a two-section structure, for example, a four-section structure, so as to detect a focus error signal in an astigmatism method. Each of the second sub-photodetectors 87 and 89 comprises at least a two-section structure so as to detect a tracking error signal in the improved push-pull method.
[0051] In this case, each of the second sub-photodetectors 87 and 89 comprises a four-section structure so as to reproduce data recorded on a DVD-RAM. Accordingly, a focus error signal can be detected in an improved astigmatism method during a reproduction of data recorded on a DVD-RAM.
[0052] FIG. 6 shows the light detection device 80 which includes the main photodetector 81 having the four-section structure A, B, C and D, the first sub-photodetectors 83 and 85 having a structure I and J, and each of the second sub-photodetectors 87 and 89 having the four-section structures E1, E2, E3 and E4, and F1, F2, F3 and F4, respectively. Detection signals therefrom are indicated by the same references. In such a case, tracking error signals TES3-BEAM and TESDPP in the three-beam method and the improved push-pull method, and a focus error signal d-FES in the improved astigmatism method (differential astigmatism method) are expressed as shown in Equations 1.
[0053] Equations 1:
TES3-BEAM=I-J
TESDPP=((A+D)-(B+C))-k({(E1+F1)+(E4+F4)}-{(E2+F2)+(E3+F3)})
d-FES=((A+C)-(B+D))-k'({(E1+F1)+(E3+F3)}-{(E2+F2)+(E4+F4)})
[0054] Here, k is a gain applied to the detection signals of the second sub-photodetectors 87 and 89 so as to detect an optimal tracking error signal in the improved push-pull method. Also, k' is a gain applied to the detection signals of the second sub-photodetectors 87 and 89 so that an optimal focusing error signal can be detected in the improved astigmatism method. In Equations 1, a sign of each detection signal from the respective sections and the first sub-photodetectors 83 and 85 indicates a current signal or a current-to-voltage converted signal output from each section of the main photodetector 81, the second sub-photodetectors 87 and 89, and the first sub-photodetectors 83 and 85.
[0055] FIG. 7 shows the structure of a light detection device circuit 90 and the signal processor 100

adopted in the optical recording/reproducing apparatus according to FIG. 6. The light detection device circuit 90 includes a plurality of current-to-voltage (I/V) converters 91 which convert the current signals output from the main photodetector 81 and the first and second sub-photodetectors 83, 85, 87, and 89 into voltage signals and output the converted signals.

[0056] As seen from the above Equations 1, in both the improved push-pull method and the improved astigmatism method, since the detection signals of each pair of the section E1 and F1, E2 and F2, E3 and F3, and E4 and F4 are summed, the light detection device circuit 90 outputs current signals from each pair of the section E1 and F1, E2 and F2, E3 and F3, and E4 and F4 that are summed and converted into voltage signals using the current-to-voltage converters 91.

[0057] Since the three-beam method and the improved push-pull method are selectively used in the optical recording/reproducing apparatus according to the embodiment of FIG. 6, the light detection device circuit 90 further includes a switch 95 which selectively outputs the detection signals of the first sub-photodetectors 83 and 85 and the second sub-photodetectors 87 and 89.

[0058] With the light detection device circuit 90 shown in FIG. 7, the number of output terminals of a light detection device circuit can be minimized.

[0059] The signal processor 100 of FIG. 7 includes a first detection portion 101 which detects a tracking error signal from detection signals of the 0<th >order beam and the +-2<nd >order beams in the improved push-pull method, and a second detection portion 103 which detects a tracking error signal from detection signals of the +-1<st >order beams in the three-beam method.

[0060] The signal processor 100 further includes a controller 105 which controls the switch 95 of the light detection device circuit 90 to detect a tracking error signal by selectively using one of the improved push-pull method and the three-beam method. The controller 105 controls the switch 95 by using an optical disc type signal detected by the optical recording/reproducing apparatus.

[0061] The first detection portion 101 includes first, second and third differentiators 101a, 101b, and 101c, and a gain adjuster 102. The first differentiator 101a receives detection signals that are output from the four sections A, B, C, and D of the main photodetector 81 (FIG. 6), which receive the 0<th >order beam. Detection signals from A, B, C and D are converted into current-to-voltage signals, and further output as a first push-pull signal. Detection signals of the sections A and D which are arranged in a direction corresponding to a tangential direction of the optical disc 30 (hereinafter, called a direction T) are input to one input terminal of the first differentiator 101a, while the detection signals form the other sections B and C are input to the other input terminal of the first differentiator 101a. The second differentiator 101b receives other detection signals that are output from the four sections E1, E2, E3, and E4 and F1, F2, F3, and F4 of the second sub-photodetectors 87 and 89, which receive the +-2<nd >order beams. They are also converted into current-to-voltage signals, and output as a second push-pull signal. Detection signals of the sections E1, E4, F1, and F4 of the second sub-photodetectors 87 and 89, which are arranged in the direction T, are input to one input terminal of the second differentiator 101b. Detection signals of the other sections E2, E3, F2, and F3 of the second sub-photodetectors 87 and 89 are input to the other input terminal of the second differentiator 101b. The second push-pull signal is amplified by the gain adjuster 102 up to a predetermined gain k. The third differentiator 101c receives and differentiates the first push-pull signal and the amplified second push-pull signal and outputs a tracking error signal TESDPP in the improved push-pull method. Here, the gain adjuster 102 adjusts the gain of the second push-pull signal so as to optimize the tracking error signal TESDPP in the improved push-pull method. The gain of the gain adjuster 102 can be controlled by the controller 105.

[0062] The second detection portion 103 includes a differentiator 103a which receives and differentiates the detection signals that are output from the first sub-photodetectors 83 and 85, which receive the +-1<st >order beams, and are converted into current-to-voltage signals. The differentiator 103a outputs a tracking error signal TES3-BEAM in the three-beam method.

[0063] The controller 105 controls the switch 95 according to the type of the optical disc 30 so as to have the first detection portion 101 output the tracking error signal TESDPP in the improved push-pull method where the optical disc 30 is a predetermined optical disc capable of recording at least once, and so as to have the second detection portion 103 output the tracking error signal TES3-BEAM in the three-beam method where the optical disc 30 is a predetermined reproduction-only optical disc. Thus, the optical recording/reproducing apparatus according to the present invention can realize the tracking servo-control in an optimal method according to the type of the optical disc 30.

[0064] For example, with a CD-ROM as the optical disc 30, the controller 105 operates the switch 95 of the light detection device circuit 90 so as to input the detection signals from the first sub-photodetectors 83 and 85 to the second detection portion 103. Accordingly, the second detection portion 103 outputs the tracking error signal TES3-BEAM in the three-beam method. In this case, no signal is output from the first detection portion 101.

[0065] In contrast, with one of a CD-R/RW and a DVD-R/RW/RAM as the optical disc 30, the controller 105 operates the switch 95 so as to input the detection signals from the main photodetector 81 and the second sub-photodetectors 87 and 89 to the first detection portion 101. Accordingly, the first detection portion 101 outputs the tracking error signal TESDPP in the improved push-pull method.

[0066] A structure which detects a tracking error signal in a differential phase detection method by using the detection signals of the main photodetector 81 in response to the optical disc 30 which comprises a

DVD-ROM, may be further included.

[0067] In the optical recording/reproducing apparatus according to the embodiment of FIGS. 6 and 7, the light beam emitted from the first light source 31 is split into a main light beam and at least four sub-light beams which are symmetrical with respect to the main light beam. The split light beams land on the optical disc 30. The main light beam and the sub-light beams reflected by the optical disc 30 are detected by the main photodetector 81, the first sub-photodetectors 83 and 85, and the second sub-photodetectors 87 and 89 which can concurrently detect tracking error signals in the three-beam method and the improved push-pull method. The signal processor 100 selectively detects a tracking error signal in one of the improved push-pull method and the three-beam method according to the type of the optical disc 30 by using detection signals of the main light beam and/or sub-light beams. Here, the controller 105 of the signal processor 100 selects a tracking error signal detection method according to an optical disc type signal and operates the switch 95 of the light detection device circuit 90 so as to detect a tracking error signal in the selected method. Thus, a tracking error signal TESDPP in the improved push-pull method is output by the first detection portion 101 with respect to an optical disc capable of recording at least one time or repeatedly, while a tracking error signal TES3-BEAM in the three-beam method is output by the second detection portion 103 with respect to an reproduction-only optical disc.

[0068] According to the above-described optical recording/reproducing apparatus, the optimal tracking servo-control can be realized by changing a tracking servo-control method according to the type of the optical disc 30.

[0069] Although the switch 95 is provided with the light detection device circuit 90 in the embodiment of FIG. 7, the light detection device circuit 90 may be formed without the switch 95. In other words, to change the tracking servo-control method, the signal processor 100 may include a switch (not shown) controlled by the controller 105 at one of the output terminals of the first and second detection portions 101 and 103, and between the light detection device circuit 90 and the first and second detection portions 101 and 103.

[0070] The present invention is not limited to an optical recording/reproducing apparatus comprising the optical splitting device 40 which splits the light beam emitted from the first light source 31 into the main light beam and the at least four sub-light beams, and the light detection device 80 having a corresponding structure so as to detect the tracking error signal in the improved push-pull method and the three-beam method.

[0071] That is, an optical recording/reproducing apparatus according to the present invention may be formed so as to detect a tracking error signal in the push-pull method and the three-beam method. In this case, a diffraction device for diffracting incident light beam into the 0<th >order beam and the +-1<st >order beams may be provided as the optical splitting device 40 so as to split the light beam emitted from the first light source 31 into the main light beam and at least two sub-light beams.

[0072] FIG. 8 shows a light detection device 180 adopted in an optical recording/reproducing apparatus according to another embodiment of the present invention. The light detection device 180 comprises the same structure as the light detection device 80 shown in FIG. 6, except the second sub-photodetectors 87 and 89 of FIG. 6 are omitted in the light detection device 180.

[0073] FIG. 9 shows the structure of a light detection device circuit 93 and a signal processor 110 adopted in the optical recording/reproducing apparatus according to FIG. 8. The light detection device circuit 93 includes current-to-voltage converters 91 which convert current signals output from the main photodetector 81 and the first sub-photodetectors 83 and 85 into voltage signals. The signal processor 110 includes a first detection portion 111 which comprises a single differentiator to detect a tracking error signal from detection signals of the four sections A, B, C and D of the main photodetector 81 in the push-pull method, and a second detection portion 113 which comprises a single differentiator to detect a tracking error signal from detection signals of the first sub-photodetectors 83 and 85 in the three-beam method.

[0074] The signal processor 110 further includes a switch 117 installed at output terminals of the first and second detection portions 111 and 113, and a controller 115 which controls the switch 117 according to the type of an optical disc. Thus, the optical recording/reproducing apparatus according to FIGS. 8 and 9 can select a tracking servo-control method according to the type of an optical disc.

[0075] The switch 117 may be installed between the light detection device circuit 93, and the first and second detection portions 111 and 113.

[0076] The tracking error signals TES3-BEAM in the three-beam method and TESPP in the push-pull method resulting from the optical recording/reproducing apparatus according to FIGS. 8 and 9 are expressed as shown in Equations 2.

[0077] Equations 2:

TES3-BEAM=I-J

TESPP=((A+D)-(B+C))

[0078] An example of an optical pickup adopted in the optical recording/reproducing apparatus according to the present invention will now be described with reference to FIG. 4.

[0079] The first light source 31 emits a light beam having, for example, a wavelength of 780 nm appropriate for recording and/or reproducing data on a CD-family optical disc. The optical system, as shown in FIG. 4, includes a first optical path changing device 53, for example, a cubic type beam splitter, and an objective lens 61 which condenses a main light beam and sub-light beams split by the optical

splitting device 40 and focuses the condensed light beams on the optical disc 30. The optical system may further include a first collimating lens 59 which collimates the light beams to the objective lens 61.

[0080] The optical pickup further includes a second light source 71 which emit a light beam having, for example, a wavelength of 650 nm so as to have compatibility with a DVD-family optical disc having a thickness different from that of the CD-family optical disc. Here, the optical system further includes a second optical path changing device 75, for example, a plate type beam splitter, which changes an optical path of the light beam emitted from the second light source 71.

[0081] The first collimating lens 59 is arranged between the objective lens 61 and the first optical path changing device 53 so as to collimate the light beam emitted from the first and second light sources 31 and 71.

[0082] Meanwhile, to improve the efficiency of the light beam emitted from the first light source 31, which lands on the optical disc 30, the optical pickup further includes a second collimating lens 51 disposed along an optical path between the first light source 31 and the first optical path changing device 53. With the second collimating lens 51 inserted along the optical path of the light beam emitted from the first light source 31, the focal length of the entire system of a collimating lens can be made short without changing the configuration of the other optical system with respect to the light beam emitted from the first light source 31. Therefore, the efficiency of the light beam emitted from the optical disc 30 can be further improved. For example, when the focal length of the first collimating lens 59 is 25 mm, the total focal length of the collimating system can be reduced to 12.5 mm by inserting the second collimating lens 51 having the focal length of 13 mm. Thus, the efficiency of the light beam emitted from the first light source 31, which lands on the optical disc 30, can be improved so as to effectively record information on the optical disc 30 that is a rewritable optical disc such as a CD-RW.

[0083] A grating 73 which diffracts the light beam emitted from the second light source 71 into the 0<th >order beam and the +-1<st >order beams can be further provided between the second light source 71 and the second optical path changing device 75 to perform a focus servo-control in an improved astigmatism method during a reproduction of data recorded on a DVD-family optical disc.

[0084] In FIG. 4, reference numeral 55 denotes a front photodetector which selectively monitors outputs of the first and second light sources 31 and 71, reference numeral 57 denotes a reflection mirror, and reference numeral 63 denotes an adjustment lens disposed between the objective lens 61 and the light detection device 80. The adjustment lens 63 makes a focus error signal detected by adjusting astigmatism of a beam input to a light receiving portion.

[0085] The optical recording/reproducing apparatus according to the present invention adopting an optical pickup having the optical configuration as shown in FIG. 4 can realize an optimal tracking servo-control according to the type of a CD-family optical disc during a reproduction of data recorded on the CD-family optical disc. Also, the optical recording/reproducing apparatus of the present invention can reproduce information recorded on CD-family and DVD-family optical discs with beams emitted from the first and second light sources 31 and 71, and can record information on a rewritable disc such as a CD-RW with a beam emitted from the first light source 31.

[0086] In addition, as the grating 73 is formed to function as the optical splitting device 40, the optical recording/reproducing apparatus according to the present invention can realize the optimal tracking servo-control during a reproduction of data recorded on a DVD-family optical disc.

[0087] Although the light detection device circuit and the signal processor of the optical recording/reproducing apparatus according to the present invention are described as being configured as shown in FIGS. 7 and 9, they are not limited thereto and can be modified in various ways within the scope of the technical concept of the present invention.

[0088] Also, FIG. 4 shows an example of an optical configuration of an optical pickup of the present invention and is not limited to such an optical configuration. For example, the optical recording/reproducing apparatus according to the present invention which adopts an optical pickup having a single light source having a wavelength of 780 nm or 650 nm can be applied to an apparatus which records and/or reproduces data on a CD-family optical disc such as a CD-RW or an apparatus which records and/or reproduces data on a DVD-family optical disc such as a DVD-RAM, respectively.

[0089] In addition, the optical recording/reproducing apparatus according to the present invention may be configured so as to have the first light source 31 emit light having a wavelength of 650 nm and the second light source 71 emit light having a wavelength of 780 nm. Such recording/reproducing apparatus realizes the optimal tracking servo-control according to the type of a DVD-family optical disc during a reproduction of data from the DVD-family optical disc. Therefore, the optical recording/reproducing apparatus of the present invention can be applied so as to reproduce information recorded on DVD-family and CD-family optical discs with light emitted from the first and second light sources 31 and 71 and/or record information on a recordable optical disc such as a DVD-R/RW/RAM with the light emitted from the first light source 31.

[0090] As described above, an optical recording/reproducing apparatus according to the present invention may selectively use one of an improved push-pull method, a push-pull method and a three-beam method according to the type of an optical disc. Therefore, an optimal tracking servo-control can be realized regardless of the depth of a pit in an optical disc during a reproduction of data from the optical disc, such as a non-rewritable optical disc.

[0091] Although a few preferred embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

Optical recording/reproducing equipment and method for testing track erroı signal

Claims of corresponding document: **US2002118611**

What is claimed is:

1. An optical recording/reproducing apparatus comprising:
an optical pickup including
an optical splitting device which splits light emitted from a first light source into a main light beam and sub-light beams which are symmetrical with respect to the main light beam, and irradiates the split main and sub-light beams on a recording medium, and
a light detection device which receives the main light beam and the sub-light beams reflected by the recording medium, and outputs detection signals corresponding to the received main and sub-light beams, so as to detect tracking error signals in a three-beam method and one of a push-pull method and an improved push-pull method; and
a signal processor which receives the detection signals output by the light detection device and detects the tracking error signals in the three-beam method and the one of the push-pull method and the improved push-pull method, and otherwise detects selectively the tracking error signal in the three-beam method and the one of the push-pull method and the improved push-pull method, so as to realize an optimal tracking servo-control.

2. The apparatus as claimed in claim 1, wherein the optimal tracking servo-control is realized by using the tracking error signal in the three-beam method in response to the recording medium being a reproduction-only recording medium, and using the tracking error signal in one of the push-pull method and the improved push-pull method in response to the recording medium being a recording medium that can be recorded on at least once, according to a recording medium type signal detected by the optical recording/reproducing apparatus.

3. The apparatus as claimed in claim 2, wherein
the sub-light beams which are symmetrical with respect to the main light beam comprise first two sub-light beams and second two sub-light beams, and
the signal processor comprises:
a first detection portion which detects the tracking error signal in the three-beam method from first detection signals with respect to the first two sub-light beams, wherein the first two sub-light beams are closer to the main light beam than the second two sub-light beams; and
a second detection portion which detects the tracking error signal in the improved push-pull method from second detection signals with respect to the second two sub-light beams and main detection signals with respect to the main light beam.

4. The apparatus as claimed in claim 3, wherein the signal processor further comprises:
a switch which is installed one of between the light detection device, and the first and second detection portions, and at output terminals of the first and second detection portions; and
a controller which controls the switch by using the recording medium type signal so as to detect the tracking error signal with one of the first and second detection portions.

5. The apparatus as claimed in claim 1, wherein
the sub-light beams which are symmetrical with respect to the main light beam comprise first two sub-light beams and second two sub-light beams, and the signal processor comprises:
a first detection portion which detects the tracking error signal in the three-beam method from first detection signals with respect to the first two sub-light beams, wherein the first two sub-light beams are closer to the main light beam than the second two sub-light beams; and
a second detection portion which detects the tracking error signal in the improved push-pull method from second detection signals with respect to the second two sub-light beams and main detection signals with respect to the main light beam.

6. The apparatus as claimed in claim 5, wherein the signal processor further comprises:
a switch which is installed one of between the light detection device, and the first and second detection portions, and at output terminals of the first and second detection portions; and
a controller which controls the switch so as to have one of the first and second detection portions detect the tracking error signal.

7. The apparatus as claimed in claim 4, wherein the controller detects the tracking error signal in the three-beam method in response to the recording medium being the reproduction-only recording medium, and detects the tracking error signal in the improved push-pull method in response to the recording medium being the recording medium which can be recorded on at least once, according to the recording medium type signal detected by the optical recording/reproducing apparatus.

8. The apparatus as claimed in claim 6, wherein the controller detects the tracking error signal in the three-beam method in response to the recording medium being a reproduction-only recording medium and the tracking error signal in the improved push-pull method in response to the recording medium being a recording medium which can be recorded on at least once, according to a recording medium type signal detected by the optical recording/reproducing apparatus.

9. The apparatus as claimed in claim 1, wherein
the sub-light beams comprise first two sub-light beams and second two sub-light beams, and
the light detection device comprises:
a main photodetector which detects the main light beam;
first sub-photodetectors which receive corresponding ones of the first two sub-light beams, wherein the first two sub-light beams are closer to the main light beam than the second two sub-light beams; and
second sub-photodetectors which receive corresponding ones of the second two sub-light beams.

10. The apparatus as claimed in claim 2, wherein
the sub-light beams comprise first two sub-light beams and second two sub-light beams, and
the light detection device comprises:
a main photodetector which detects the main light beam;
first sub-photodetectors which receive corresponding ones of the first two sub-light beams, wherein the first two sub-light beams are closer to the main light beam than the second two sub-light beams; and
second sub-photodetectors which receive corresponding ones of the second two sub-light beams.

11. The apparatus as claimed in claim 3, wherein the light detection device comprises:
a main photodetector which detects the main light beam;
first sub-photodetectors which receive corresponding ones of the first two sub-light beams; and
second sub-photodetectors which receive corresponding ones of the second two sub-light beams.

12. The apparatus as claimed in claim 5, wherein the light detection device comprises:
a main photodetector which detects the main light beam;
first sub-photodetectors which receive corresponding ones of the first two sub-light beams; and
second sub-photodetectors which receive corresponding ones of the second two sub-light beams.

13. The apparatus as claimed in claim 9, wherein
the main photodetector comprises of a plurality of sections, and
each of the second sub-photodetectors comprises of one of two sections and four sections.

14. The apparatus as claimed in claim 9, further comprising a light detection device circuit including:
a current-to-voltage converting unit which converts each of current signals output from the main photodetector and the first and second sub-photodetectors into a corresponding one of voltage signals, and outputs each of the converted voltage signals as a corresponding one of the detection signals; and
a switch which selectively outputs each of the detection signals from a corresponding one of the first and second sub-photodetectors.

15. The apparatus as claimed in claim 14, wherein the signal processor detects the tracking error signal selectively in one of the improved push-pull method and the three-beam method, and outputs the detected tracking error signal, by controlling the switch according to a recording medium type signal of the optical recording/reproducing apparatus.

16. The apparatus as claimed in claim 1, further comprising a light detection device circuit including a current-to-voltage converting unit which converts each of current signals output from the light detection device into a corresponding one of voltage signals and outputs each of the converted voltage signals as a corresponding one of the detection signals.

17. The apparatus as claimed in claim 2, further comprising a light detection device circuit including a current-to-voltage converting unit which converts each of current signals output from the light detection device into a corresponding one of voltage signals and outputs each of the converted voltage signals as a corresponding one of the detection signals.

18. The apparatus as claimed in claim 3, further comprising a light detection device circuit including a

current-to-voltage converting unit which converts each of current signals output from the light detection device into a corresponding one of voltage signals and outputs each of the converted voltage signals as a corresponding one of the main, first and second detection signals.

19. The apparatus as claimed in claim 4, further comprising a light detection device circuit including a current-to-voltage converting unit which converts each of current signals output from the light detection device into a corresponding one of voltage signals and outputs each of the converted voltage signals as a corresponding one of the main, first and second detection signals.

20. The apparatus as claimed in claim 5, further comprising a light detection device circuit including a current-to-voltage converting unit which converts each of current signals output from the light detection device into a corresponding one of voltage signals and outputs each of the converted voltage signals as a corresponding one of the main, first and second detection signals.

21. The apparatus as claimed in claim 6, further comprising a light detection device circuit including a current-to-voltage converting unit which converts each of current signals output from the light detection device into a corresponding one of voltage signals and outputs each of the converted voltage signals as a corresponding one of the main, first and second detection signals.

22. The apparatus as claimed in claim 1, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.

23. The apparatus as claimed in claim 2, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.

24. The apparatus as claimed in claim 3, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.

25. The apparatus as claimed in claim 4, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.

26. The apparatus as claimed in claim 5, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.

27. The apparatus as claimed in claim 6, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order, +-1<st >order, and +-2<nd >order diffracted light beams.

28. The apparatus as claimed in claim 22, wherein the diffracting device performs diffraction so as to have a diffraction ratio between the 0<th >order, the +-1<st >order, and the +-2<nd >order diffracted light beams that is substantially 8-16:0.3-2.3:0.3-2.3, and a total diffraction efficiency of the 0<th >order, the +-1<st >order, and the +-2<nd >order diffracted light beams with respect to an incident light beam that is at least 70%.

29. The apparatus as claimed in claim 1, wherein the sub-light beams comprises first two sub-light beams which are closest to the main light beam and have a phase difference of about 180[deg.] with respect to each other.

30. The apparatus as claimed in claim 2, wherein the sub-light beams comprises first two sub-light beams which are closest to the main light beam and have a phase difference of about 180[deg.] with respect to each other.

31. The apparatus as claimed in claim 3, wherein the first two sub-light beams and have a phase difference of about 180[deg.] with respect to each other.

32. The apparatus as claimed in claim 4, wherein the first two sub-light beams and have a phase difference of about 180[deg.] with respect to each other.

33. The apparatus as claimed in claim 5, wherein the first two sub-light beams and have a phase difference of about 180[deg.] with respect to each other.

34. The apparatus as claimed in claim 6, wherein the first two sub-light beams and have a phase difference of about 180[deg.] with respect to each other.

35. The apparatus as claimed in claim 2, wherein
the sub-light beams which are symmetrical with respect to the main light beam comprise two sub-light beams, and
the signal processor comprises:
a first detection portion which detects the tracking error signal in the push-pull method by using main detection signals with respect to the main light beam; and
a second detection portion which detects the tracking error signal in the three-beam method by using second detection signals with respect to the two sub-light beams which are symmetrical with respect to the main light beam.

36. The apparatus as claimed in claim 35, wherein the signal processor further comprises:
a switch which is installed at output terminals of the first and second detection portions; and
a controller which controls the switch by using the recording medium type signal so as to output the tracking error signal selectively from one of the first and second detection portions.

37. The apparatus as claimed in claim 1, wherein
the sub-light beams which are symmetrical with respect to the main light beam comprise two sub-light beams, and
the signal processor comprises:
a first detection portion which detects the tracking error signal in the push-pull method by using main detection signals with respect to the main light beam; and
a second detection portion which detects the tracking error signal in the three-beam method by using second detection signals with respect to the two sub-light beams which are symmetrical with respect to the main light beam.

38. The apparatus as claimed in claim 37, wherein the signal processor further comprises:
a switch which is installed at output terminals of the first and second detection portions; and
a controller which controls the switch by using a recording medium type signal detected by the optical recording/reproducing apparatus so as to output the tracking error signal selectively from one of the first and second detection portions.

39. The apparatus as claimed in claim 35, wherein the light detection device comprises:
a main photodetector which detects the main light beam; and
sub-photodetectors which receive corresponding ones of the two sub-light beams.

40. The apparatus as claimed in claim 36, wherein the light detection device comprises:
a main photodetector which detects the main light beam; and
sub-photodetectors which receive corresponding ones of the two sub-light beams.

41. The apparatus as claimed in claim 37, wherein the light detection device comprises:
a main photodetector which detects the main light beam; and
sub-photodetectors which receive corresponding ones of the two sub-light beams.

42. The apparatus as claimed in claim 38, wherein the light detection device comprises:
a main photodetector which detects the main light beam; and
sub-photodetectors which receive corresponding ones of the two sub-light beams.

43. The apparatus as claimed in claim 39, wherein the main photodetector comprises a structure having a plurality of sections.

44. The apparatus as claimed in claim 1, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order and +-1<st >order diffracted light beams.

45. The apparatus as claimed in claim 2, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order and +-1<st >order diffracted light beams.

46. The apparatus as claimed in claim 35, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order and +-1<st >order diffracted light beams.

47. The apparatus as claimed in claim 36, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order and +-1<st >order diffracted light beams.

48. The apparatus as claimed in claim 37, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order and +-1<st >order diffracted light beams.

49. The apparatus as claimed in claim 38, wherein the optical splitting device comprises a diffracting device which diffracts the light emitted from the first light source into 0<th >order and +-1<st >order diffracted light beams.

50. The apparatus as claimed in claim 1, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main light beam and the sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

51. The apparatus as claimed in claim 2, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main light beam and the sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

52. The apparatus as claimed in claim 3, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

53. The apparatus as claimed in claim 4, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

54. The apparatus as claimed in claim 5, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

55. The apparatus as claimed in claim 6, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

56. The apparatus as claimed in claim 35, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

57. The apparatus as claimed in claim 36, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

58. The apparatus as claimed in claim 37, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

59. The apparatus as claimed in claim 38, wherein the optical pickup further comprises:
a first optical path changing device which changes a proceeding path of an incident light; and
an objective lens which condenses the main and sub-light beams split by the optical splitting device, and focuses the condensed main and sub-light beams on the recording medium.

60. The apparatus as claimed in claim 50, wherein the optical pickup further comprises an adjustment lens which adjusts astigmatism of light reflected by the recording medium.

61. The apparatus as claimed in claim 60, wherein the sub-light beams comprises first two sub-light beams and second two sub-light beams, and the light detection device comprises:
a main photodetector which detects the main light beam;
first photodetectors which receive corresponding ones of the first two sub-light beams, wherein the first two sub-light beams are closer to the main light beams than the second two sub-light beams; and
second photodetectors which receive corresponding ones of the second two sub-light beams, wherein each of the second sub-photodetectors of the optical pickup comprises of four sections so as to detect a focus error signal in an improved astigmatism method, wherein the improved astigmatism (d-FES) is determined according to:
d-FES=((A+C)-(B+D))-k'({(E1+F1)+(E3+F3)}-{(E2+F2)+(E4+F4)})
where A, B, C and D are main detection signals from the main photodetector, E1, E2, E3, E4, F1, F2, F3 and F4 are second detection signals from the second photodetectors, and k' is a gain applied to the second detection signals.

62. The apparatus as claimed in claim 50, wherein the optical pickup further comprises:
a second light source which emits light having a wavelength different from that of the light from the first light source; and
a second optical path changing device which irradiates the light emitted from the second light source toward the recording medium, so as to compatibly adopt to recording media having different formats.

63. The apparatus as claimed in claim 62, further comprising a first collimating lens which collimates the light emitted from the first and second light sources.

64. The apparatus as claimed in claim 63, further comprising a second collimating lens which is situated between the first light source and the first collimating lens.

65. The apparatus as claimed in claim 62, wherein one of the first and second light sources emits light having a wavelength appropriate for recording/reproducing information with respect to a CD-family recording medium and the other light source emits light having a wavelength appropriate for recording/reproducing information with respect to a DVD-family recording medium.

66. The apparatus as claimed in claim 1, wherein the optical pickup further comprises a second light source which emits light having a wavelength different from that of the light emitted from the first light source, wherein the light emitted from the second light source land on the recording medium, so as to compatibly adopt to recording media having different formats.

67. The apparatus as claimed in claim 2, wherein the optical pickup further comprises a second light source which emits light having a wavelength different from that of the light emitted from the first light source, wherein the light emitted from the second light source land on the recording medium, so as to compatibly adopt to recording media having different formats.

68. A method of detecting a tracking error signal in an optical recording/reproducing apparatus, the method comprising:
splitting light emitted from a light source into a main light beam and sub-light beams which are symmetrical with respect to the main light beam;
irradiating the split light beams on a recording medium;
detecting the main light beam and the sub-light beams reflected by the recording medium; and
detecting the tracking error signal by using detection signals of the main light beam and/or the sub-light beams in a three-beam method and one of a push-pull method and an improved push-pull method, and otherwise in one of the three-beam method, the push-pull method, and the improved push-pull method.

69. The method as claimed in claim 68, wherein the detecting of the tracking error signal comprises:
selecting a tracking servo-control method including one or a combination of the three-beam method, the push-pull method and the improved push-pull method according to a recording medium type signal detected by the optical recording/reproducing apparatus; and
detecting the tracking error signal according to the selected tracking servo-control method.

70. The method as claimed in claim 68, wherein, the detecting of the tracking error signal comprises:
using a recording medium type signal detected by the optical recording/reproducing apparatus; and
detecting the tracking error signal in the three-beam method in response to the recording medium being a reproduction-only recording medium, and detecting the tracking error signal in one of the push-pull method and the improved push-pull method in response to the recording medium being a recording medium which can be recorded on at least once.

71. The method as claimed in claim 69, wherein, the detecting of the tracking error signal comprises:
using the recording medium type signal detected by the optical recording/reproducing apparatus; and detecting the tracking error signal in the three-beam method in response to the recording medium being a reproduction-only recording medium, and detecting the tracking error signal in one of the push-pull method and the improved push-pull method in response to the recording medium being a recording medium which can be recorded on at least once.

72. An optical recording/reproducing apparatus comprising:
an optical pickup including
an optical splitting device which splits light emitted from a first light source into a main light beam and sub-light beams which are symmetrical with respect to the main light beam, and irradiates the split main and sub-light beams, and
a light detection device which receives the main and sub-light beams reflected from a recording medium, and outputs detection signals corresponding to the received main and sub-light beams; and
a signal processor which receives the detection signals and detects tracking error signals in a three-beam method and one of a push-pull method and an improved push-pull method, and otherwise detects the tracking error signal by selectively using the detection signals corresponding to one of the three-beam method, the push-pull method and the improved push-pull method according to a recording medium type signal, so as to realize an optimal tracking servo-control.

73. The apparatus as claimed in claim 72, wherein the signal processor detects the tracking error signal in the three-beam method in response to the recording medium which comprises a reproduction-only recording medium, and in one of the push-pull method and the improved push-pull method in response to the recording medium which comprises a recordable recording medium, according to the recording medium type signal detected by the optical recording/reproducing apparatus.

74. The apparatus as claimed in claim 73, wherein the optical pickup further comprises a second light source which emits a second light having a wavelength different from that of the light from the first light source, wherein the second light is irradiated on the recording medium so as allow the optical recording/reproducing apparatus to compatibly adopt to recording media having different formats.

*75. An optical recording/reproducing apparatus comprising:
an optical pickup including
an optical splitting device which splits light emitted from a first light source into a main light beam and sub-light beams which are symmetrical with respect to the main light beam, and irradiates the split main and sub-light beams, and
a light detection device which receives the main and sub-light beams reflected from a recording medium, and outputs detection signals corresponding to the received main and sub-light beams; and
a signal processor which receives the detection signals and detects a tracking error signal in accordance with a plurality of tracking servo control methods according to a type of the recording medium and independent of depths of pits formed in the recording medium.

76. An optical recording/reproducing apparatus comprising:
an optical pickup including
an optical splitting device which splits light emitted from a first light source into a main light beam and sub-light beams which are symmetrical with respect to the main light beam, and irradiates the split main and sub-light beams, and
a light detection device which receives the main and sub-light beams reflected from a recording medium, and outputs detection signals corresponding to the received main and sub-light beams; and
a signal processor which receives the detection signals and detects tracking error signals in a three-beam method and a push-pull method according to a recording medium type signal detected by the optical recording/reproducing apparatus.

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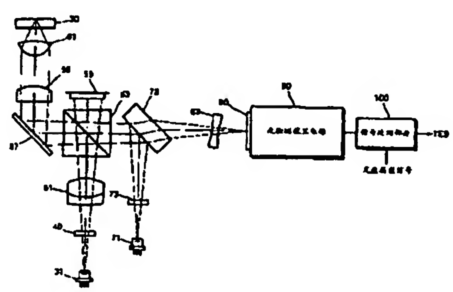
[54]发明名称 光记录/再现设备和跟踪误差信号检测方法

[57]摘要

一种光记录/再现设备，包括光学拾取器，该光拾取器包括：分光装置，用于把第一光源发射的光分解成主光束和对称于主光束的至少两个副光束，并使分解的光束照射到记录介质上；光检测装置，用于接收由记录介质反射 的主光束和副光束，以便采用推挽方法及改进的推挽方法之一和三光束方法 检测跟踪误差信号；和信号处理器，用于接收由光检测装置输出的检测信号，并采用推挽方法及改进的推挽方法之一和三光束方法检测跟踪误差信号，或 者采用三光束方法、推挽方法和改进的推挽方法之一选择性地检测跟踪误差 信号，以便实现最佳跟踪伺服控制。因此，在从非可重写光盘中再现数据期间可以实现最佳跟踪伺服控制，而无需考虑光盘凹坑的深度。



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权利要求书

1. 一种光记录/再现设备，包括光拾取器和检测跟踪误差信号的信号处理器，其特征在于该光拾取器包括：

分光装置，用于把第一光源发射的光分解成一个主光束和对称于该主光束的至少两个副光束，并且使分解的光束照射到记录介质上，以便采用推挽方法和改进的推挽方法中的至少一种方法和三光束方法检测跟踪误差信号；和

光检测装置，用于接收由所述记录介质反射的主光束和副光束，并且将对应于所接收的光束的检测信号输出给所述信号处理器，和

所述信号处理器接收从所述光检测装置输出的检测信号，并采用推挽方法及改进的推挽方法中的一种方法和三光束方法检测跟踪误差信号，或者选择性地使用三光束方法、推挽方法和改进的推挽方法中的一种方法检测跟踪误差信号，以便实现最佳跟踪伺服控制。

2. 根据权利要求 1 所述的设备，其中根据光记录/再现设备检测的记录介质类型信号，当所述记录介质仅仅是用于再现的预定记录介质时，通过使用三光束方法的跟踪误差信号来实现跟踪伺服控制，当所述记录介质是至少可以记录一次的预定记录介质时，通过使用推挽方法和改进的推挽方法中的一种方法的跟踪误差信号来实现跟踪伺服控制。

3. 根据权利要求 2 所述的设备，其中所述分光装置把所述第一光源发射的光分解成主光束和至少四个对称于主光束的副光束，并且所述信号处理器包括：

第一检测部分，用于采用三光束方法从关于比较接近主光束的两个副光束的第一检测信号中检测跟踪误差信号；和

第二检测部分，用于采用改进的推挽方法从关于相距主光束较远的两个副光束的第二检测信号以及关于主光束的主检测信号中检测跟踪误差信号。

4. 根据权利要求 3 所述的设备，其中所述信号处理器还包括：

安装在所述光检测装置与所述第一和第二检测部分之间或安装在所述第一和第二检测部分的输出端子上的开关；和

控制器，用于通过使用所述记录介质类型信号控制所述开关，以便由所述第一或第二检测部分检测跟踪误差信号。

5. 根据权利要求 1 所述的设备，其中所述分光装置把第一光源发射的光分解成主光束和至少四个对称于主光束的副光束，并且所述信号处理器包括：

第一检测部分，用于采用三光束方法从关于比较接近主光束的两个副光束的第一检测信号中检测跟踪误差信号；和

第二检测部分，用于采用改进的推挽方法从关于相距主光束较远的两个副光束的第二检测信号以及关于主光束的主检测信号中检测跟踪误差信号。

6. 根据权利要求 5 所述的设备，其中所述信号处理器还包括：

安装在所述光检测装置与所述第一和第二检测部分之间或安装在所述第一和第二检测部分的输出端子上的开关；和

控制器，用于控制所述开关，以便所述第一或第二检测部分检测跟踪误差信号。

7. 根据权利要求 4 或 6 所述的设备，其中操作控制器以根据所述光记录/再现设备检测的记录介质类型信号，当所述记录介质仅仅是用于再现的预定记录介质时，使用三光束方法检测跟踪误差信号，当所述记录介质是至少可以记录一次的预定记录介质时，使用改进的推挽方法检测跟踪误差信号。

8. 根据权利要求 1 至 3 和 5 的任一项所述的设备，其中所述光检测装置包括：

一个主光电检测器，用于检测主光束；

一对第一副光电检测器，用于接收比较接近主光束的两个副光束；和

一对第二副光电检测器，用于接收相距主光束较远的两个副光束。

9. 根据权利要求 8 所述的设备，其中主光电检测器具有一个至少有两个部分的结构，以及第二光电检测器具有一个有两个和四个部分中的一种的结构。

10. 根据权利要求 8 所述的设备，还包括光检测装置电路，该电路包括：电流-电压转换器，用于将从主光电检测器和第一及第二副光电检测器输出的电流信号转换成电压信号，并且输出该转换的电压；和开关，用于选择性地输出来自第一副光电检测器的检测信号和来自第二副光电检测器的检测信号。

11. 根据权利要求 10 所述的设备，其中所述信号处理器通过根据所述

光记录/再现设备的记录介质类型信号控制所述开关，选择性地采用改进的推挽方法或三光束方法检测跟踪误差信号。

12. 根据权利要求 1 至 6 的任一项所述的设备，还包括光检测装置电路，所述电路包括电流-电压转换器，用于将从所述光检测装置输出的电流信号转换为电压信号并输出经转换的信号。

13. 根据权利要求 1 至 6 的任一项所述的设备，其中分光装置是一个衍射装置，将光源发射的光分解成第 0 阶、第 ±1 阶和第 ±2 阶衍射光束。

14. 根据权利要求 13 所述的设备，其中衍射装置进行衍射，使第 0 阶、第 ±1 阶和第 ±2 阶衍射光束之间的衍射比值基本上是 8-16: 0.3-2.3: 0.3-2.3，以及使第 0 阶、第 ±1 阶和第 ±2 阶衍射光束关于入射光束的总衍射效率超过 70%。

15. 根据权利要求 1 至 6 的任一项所述的设备，其中比较接近主光束并且照射到记录介质上的两个副光束之间的相位差约为 180° 。

16. 根据权利要求 2 所述的设备，其中所述分光装置将从第一光源发射的光束分解成主光束和至少两个对称于主光束的副光束，以及所述信号处理器包括:

第一检测部分，用于通过使用关于主光束的检测信号采用推挽方法检测跟踪误差信号；和

第二检测部分，用于通过使用关于对称于主光束的至少两个副光束的检测信号采用三光束方法检测跟踪误差信号。

17. 根据权利要求 16 所述的设备，其中所述信号处理器还包括:

安装在所述第一和第二检测部分的输出端子上的开关；和

控制器，用于通过使用记录介质类型信号控制所述开关，以便选择性地从所述第一或第二检测部分输出跟踪误差信号。

18. 根据权利要求 1 所述的设备，其中所述分光装置将第一光源发射的光束分解成主光束和至少两个对称于主光束的副光束，以及所述信号处理器包括:

第一检测部分，用于通过使用关于主光束的检测信号采用推挽方法检测跟踪误差信号；和

第二检测部分，用于通过使用关于对称于主光束的两个副光束的检测信号采用三光束方法检测跟踪误差信号。

19. 根据权利要求 18 所述的设备，其中所述信号处理器还包括:

安装在所述第一和第二检测部分的输出端子上的开关；和

控制器，用于通过使用由所述记录/再现设备检测的所述记录介质类型信号控制所述开关，以便选择性地从所述第一或第二检测部分输出跟踪误差信号。

20. 根据权利要求 16 至 19 的任一项所述的设备，其中所述光检测装置包括:

主光电检测器，用于检测主光束；和

一对副光电检测器，用于接收两个副光束。

21. 根据权利要求 20 所述的设备，其中所述主光电检测器具有一个有至少两个部分的结构。

22. 根据权利要求 1、2、16 至 19 的任一项所述的设备，其中所述分光装置是将所述光源发射的光分解成第 0 阶、第 ±1 阶衍射光束的衍射装置。

23. 根据权利要求 1 至 6 和 16 至 19 的任一项所述的设备，其中所述光拾取器包括:

第一光径改变装置，用于改变入射光的前进路径；和

物镜，用于聚集由所述分光装置分解的主光束和副光束，并且将聚集的光聚焦到所述记录介质上。

24. 根据权利要求 23 所述的设备，其中所述光拾取器还包括调节透镜，用于调节由所述记录介质反射的光的象散。

25. 根据权利要求 24 所述的设备，其中所述光拾取器的所述第二副光电检测器具有一个有四个部分的结构，以采用改进的象散方法检测聚焦误差信号。

26. 根据权利要求 23 所述的设备，其中所述光拾取器还包括:

第二光源，用于发射具有不同于来自所述第一光源的光的波长的波长的光；和

第二光径改变装置，用于使所述第二光源发射的光前进到所述记录介质上，以便可以兼容地采用具有不同格式的记录介质。

27. 根据权利要求 26 所述的设备，还包括第一准直透镜，用于准直从所述第一和第二光源发射的光。

28. 根据权利要求 27 所述的设备，还包括位于所述第一光源与所述第

一准直透镜之间的第二准直透镜。

29. 根据权利要求 26 所述的设备，其中所述第一和第二光源中的一个发射具有适合于记录/再现与 CD 族记录介质有关的信息的波长的光；另一个光源发射具有适合于记录/再现与 DVD 族记录介质有关的信息的波长的光。

30. 根据权利要求 1 或 2 所述的设备，其中所述光拾取器还包括第二光源，发射具有不同于来自所述第一光源的光的波长的波长的光，并且被设置为能够使所述第二光源发射的光照射到所述记录介质上，以便兼容地采用具有不同格式的所述记录介质。

31. 一种检测跟踪误差信号的方法，包括以下步骤：

把第一光源发射的光分解成主光束和对称于主光束的至少两个副光束，并且使分解的光束照射到记录介质上；

检测由所述记录介质反射的主光束和副光束；

通过使用主光束和/或副光束的检测信号，采用推挽方法和改进的推挽方法中的一种方法和三光束方法、或采用从三光束方法、推挽方法和改进的推挽方法中选择的一种方法检测跟踪误差信号。

32. 根据权利要求 31 所述的方法，其中跟踪误差信号检测步骤包括以下子步骤：

根据由所述光记录/再现方法检测的记录介质类型信号选择跟踪伺服控制方法；和

根据所选择的伺服控制方法检测跟踪误差信号。

33. 根据权利要求 31 或 32 所述的方法，其中在跟踪误差信号检测步骤中，通过使用由所述光记录/再现设备检测的记录介质类型信号，当所述记录介质仅仅是用于再现的预定记录介质时，采用三光束方法检测跟踪误差信号，以及当所述记录介质是可以在其上至少记录一次的预定记录介质时，采用推挽方法和改进的推挽方法中的一种方法检测跟踪误差信号。

说 明 书

光记录/再现设备和跟踪误差信号检测方法

技术领域

本发明涉及一种根据记录介质比如光盘的类型实现最佳跟踪伺服控制的光记录/再现设备，和检测跟踪误差信号的方法。

背景技术

一般来说，再现设备主要以三光束方法执行跟踪伺服控制，而记录设备则以推挽方法执行跟踪伺服控制，特别是以差分推挽（DPP）方法执行误差跟踪控制，该差分推挽方法是一种改进的推挽方法。

三光束方法和 DPP 方法都利用了通过光栅分解成第 0 和第 ±1 阶(order)的光束。在使用三光束方法的再现设备中，根据再现期间光束的强度采用了这样一种光栅：在该光栅中，第 0 与第 ±1 阶光束之间衍射的有效比值约为 4:1 至 5:1，即，第 0 阶：第 ±1 阶 = 4:1 至 5:1。照射到光盘上的第 +1 阶光束与第 -1 阶光束之间的相位差被设置为 180°。

如图 1 所示，再现设备使六部分光电检测器 10，包括一个主光电检测器 11；主光电检测器 11 具有一个四部分结构和设置在主光电检测器 11 的两侧的一对副光电检测器 13 和 15。通过检测由光栅衍射的三个光束用三光束方法实现跟踪伺服控制。这里，按三光束方法检测的跟踪误差信号是副光电检测器 13 和 15 的检测信号之间的差分信号。

在使用 DPP 方法的记录设备中，采用这样一种光栅来增加用于记录的第 0 阶光束的效率：在该光栅中第 0 与第 ±1 阶光束之间衍射的有效比值约为 10:1 至 15:1。照射到光盘上的第 +1 阶光束与第 -1 阶光束之间的相位差被设置为 360°。

如图 2 所示，记录设备使用八部分光电检测器 20，包括一个主光电检测器 21；该主光电检测器 21 具有一个四部分结构和设置在主光电检测器 21 两侧的一对两部分副光电检测器 23 和 25。通过检测由光栅分解的三个光束实现跟踪伺服控制。这里，按 DPP 方法检测的跟踪误差信号是副光电检测器 23 和 25 的部分 I1 和 J1 的检测信号的总信号与副光电检测器 23 和 25 的部

分 I2 和 J2 的检测信号的总信号之间的差值。

根据光盘中的凹坑的深度，按三光束方法和推挽方法检测的跟踪误差信号具有不同的幅值。如图 3 所示，当光盘的凹坑深度是λ/4 时，按三光束方法检测的跟踪误差信号（$TES_{3\text{-}BEAM}$）的幅值变为最大。反之，当光盘的凹坑深度是λ/8 时，按推挽方法检测的跟踪误差信号（TES_{DPP}）的幅值变为最大，而当光盘的凹坑深度是λ/4 时，其幅值则变为最小。

因此，把光盘的凹坑深度标准化为中间值λ/5，以便在采用上述伺服控制方法的任何一个方法时可以实现跟踪伺服控制。

然而，目前销售的许多光盘被这样制造：形成比标准尺寸更深的凹坑深度，接近于λ/4。当从具有被制造成比标准尺寸更深的凹坑的光盘中再现数据时，由采用三光束方法的再现设备检测的跟踪误差信号的幅值很大，反之采用推挽方法的再现设备检测的跟踪误差信号的幅值则接近于 0，使得跟踪伺服控制本身变得不可能。

发明内容

为了解决上述问题，本发明的目的是提供一种光记录/再现设备，和一种检测跟踪误差信号的方法，该设备和方法通过根据光盘类型改变跟踪伺服控制方法，可以在从非重写光盘中再现数据期间实现最佳跟踪伺服控制，并且无需考虑凹坑的深度。

为了实现上述目的，提供了一种光记录/再现设备，包括：一个光拾取器，该光拾取器包括一个把从第一光源发射的光分解成一个主光束和对称于主光束的至少两个副光束、并且使分解的光束照射到记录介质上的分光装置；和一个光检测装置，用于接收由记录介质反射的主光束和副光束，以便采用三光束方法和推挽方法及改进的推挽方法中的至少一种方法检测跟踪误差信号；以及一个信号处理器，用于接收由光检测装置输出的检测信号，并采用三光束方法和推挽方法及改进的推挽方法中的一种方法检测跟踪误差信号，或者采用三光束方法、推挽方法和改进的推挽方法之一种方法选择性地检测跟踪误差信号，以便实现最佳跟踪伺服控制。

本发明最好是，根据光记录/再现设备检测的记录介质类型信号，当记录介质仅仅是用于再现的预定记录介质时，通过使用三光束方法的跟踪误差信号实现跟踪伺服控制，当记录介质是一种至少可以在其上记录一次的预定

记录介质时，使用推挽方法和改进的推挽方法中的一种方法的跟踪误差信号实现跟踪伺服控制。

本发明最好是，分光装置把第一光源发射的光分解成主光束和至少四个对称于主光束的副光束，并且信号处理器包括：第一检测部分，用于采用三光束方法从关于比较接近主光束的两个副光束的第一检测信号中检测跟踪误差信号；和第二检测部分，用于采用改进的推挽方法从关于相距主光束较远的两个副光束的第二检测信号以及关于主光束的主检测信号中检测跟踪误差信号。

本发明最好是，信号处理器还包括一个安装在光检测装置与第一和第二检测部分之间或安装在第一和第二检测部分的输出端上的开关；和一个控制器，通过使用记录介质类型信号控制该开关，以便由第一或第二检测部分检测跟踪误差信号。

本发明最好是，光检测装置包括：一个检测主光束的主光电检测器；一对第一副光电检测器，用于接收比较接近主光束的两个副光束；和一对第二副光电检测器，用于接收相距主光束较远的两个副光束。

本发明最好是，主光电检测器具有一个至少两个部分的结构，以及第二副光电检测器具有一个两个和四个部分中的一种的结构。

本发明最好是，光记录/再现设备还包括：一个光检测装置电路，该电路包括一个电流-电压转换器，用于将从主光电检测器和第一及第二副光电检测器输出的电流信号转换成电压信号，并且输出经转换的信号；和一个开关，选择性地输出来自第一副光电检测器的检测信号和来自第二副光电检测器的检测信号。

本发明最好是，分光装置是一个衍射装置，该装置将光源发射的光分解成第 0 阶、第 ±1 阶和第 ±2 阶衍射的光束。

本发明最好是，衍射装置进行衍射，使第 0 阶、第 ±1 阶和第 ±2 阶衍射光束之间的衍射比值基本上是 8-16: 0.3-2.3: 0.3-2.3，并且第 0 阶、第 ±1 阶和第 ±2 阶衍射光束关于入射光的总衍射效率超过 70%。

本发明最好是，分光装置将第一光源发射的光束分解成主光束和至少两个对称于主光束的副光束，以及信号处理器包括：一个第一检测部分，用于通过使用关于主光束的检测信号采用推挽方法检测跟踪误差信号；和一个第二检测部分，用于通过使用关于对称于主光束的两个副光束的检测信号采用

三光束方法检测跟踪误差信号。

本发明最好是，信号处理器还包括：一个安装在第一和第二检测部分的输出端子上的开关；和一个控制器，用于通过使用记录介质类型信号控制该开关，以便选择性地从第一或第二检测部分输出跟踪误差信号。

本发明最好是，光检测装置包括：一个检测主光束的主光电检测器，和一对接收两个副光束的副光电检测器。该主光电检测器具有一个至少两个部分的结构。

为了实现上述目的的另一方面，提供了一种检测跟踪误差信号的方法，包括以下步骤：把从光源发射的光分解成一个主光束和对称于主光束的至少两个副光束，并且使分解的光束照射到记录介质上；检测由记录介质反射的主光束和副光束；通过使用采用推挽方法及改进的推挽方法中的一种方法和三光束方法、或采用从三光束方法和推挽方法及改进的推挽方法中选择的一种方法的主光束和/或副光束的检测信号检测跟踪误差信号。

本发明最好是，跟踪误差信号检测步骤包括以下子步骤：根据用光记录/再现方法检测的记录介质类型信号选择跟踪伺服控制方法，和根据所选择的伺服控制方法检测跟踪误差信号。

本发明最好是，在跟踪误差信号检测步骤中，通过使用由光记录/再现设备检测的记录介质类型信号，当记录介质仅仅是用于再现的预定记录介质时，采用三光束方法检测跟踪误差信号，以及当记录介质是至少可以在其上记录一次的预定记录介质时，采用推挽方法和改进的推挽方法中的一种方法检测跟踪误差信号。

附图说明

通过结合附图对优选实施例的详细说明，本发明的上述目的和优点将变得更加清楚，其中：

图 1 是显示在传统再现设备中采用的六部分光电检测器的平面图；

图 2 是显示在传统记录设备中采用的八部分光电检测器的平面图；

图 3 是根据三光束方法和改进的推挽方法的关于光盘凹坑的深度的跟踪误差信号的曲线图；

图 4 是显示本发明的记录/再现设备的结构的示意图；

图 5 是显示照射在图 4 的光盘上的衍射光束的示意图；

图 6 是显示在根据本发明的第一优选实施例的光记录/再现设备中采用的光电检测器装置的视图；

图 7 是实现在本发明的第一优选实施例的光记录/再现设备中采用的最佳跟踪伺服控制的电路图；

图 8 是显示在根据本发明的第二优选实施例的光记录/再现设备中采用的光电检测器装置的视图；和

图 9 是实现在本发明的第二优选实施例的光记录/再现设备中采用的最佳跟踪伺服控制的电路图。

具体实施方式

本发明的特征在于：通过使用当光盘第一次插入整个光记录/再现设备时判别光盘类型的特征，在插入诸如 CD-ROM 的用于再现的光盘时按照三光束方法执行跟踪伺服控制，和在插入诸如 CD-R/RW 和/或 DVD-RAM 的用于记录的光盘时按照推挽方法或改进的推挽方法执行跟踪伺服控制。当采用本发明的上述技术时，记录设备的光拾取器可以不考虑用于再现的光盘的凹坑深度而稳定地实现跟踪伺服控制。

参见图 4，本发明的优选实施例的光记录/再现设备包括：光拾取器，用于把主光束照射到光盘 30 的主轨道上和照射至少四个对称于主光束的副光束至光盘 30，并且接收和检测由光盘 30 反射的主光束和副光束；和信号处理器 100，通过使用主光束和副光束的检测信号，以改进的推挽方法或三光束方法选择性地检测跟踪误差信号。

光拾取器包括：第一光源 31；分光装置 40，用于将第一光源 31 发射的光分解成主光束和至少四个对称于主光束的副光束；光学系统，用于将分光装置 40 分解的光束引导到光盘 30 上；和光检测装置 80，用于接收由光盘 30 反射的主光束和副光束。

例如光栅的衍射装置被设置为分光装置 40，用于通过把第一光源 31 发射的光束衍射成第 0 阶、第 ±1 阶和第 ±2 阶等光束，将第一光源 31 发射的光束分解成至少五个光束。这里，第 0 阶光束成为主光束，第 ±1 阶光束成为比较接近主光束的两个第一副光束，第 ±2 阶光束成为相距主光束较远的两个第二副光束。在这里，可以把全息装置设置为分光装置 40。

分光装置 40 以大约 8-16: 0.3-2.3: 0.3-2.3、最好是 14: 0.5: 1 的衍射

比值将光源 31 发射的光束分解为第 0 阶光束、第 ±1 阶光束和第 ±2 阶光束，使得衍射成为第 0 阶光束、第 ±1 阶光束和第 ±2 阶光束关于入射光束的总效率超过 70%，最好 90%。

分光装置 40 的间距和光学系统的结构是这样配置的，它使衍射的光束被入射到如图 5 所示的光盘 30 的表面，其中当分光装置 40 衍射的光束被照射到光盘 30 上时，最好在第+1 阶光束与第-1 阶光束之间生成 180° 相位差。这里，在第+2 阶光束与第-2 阶光束之间生成 360° 相位差。当照射在光盘 30 上的衍射光束具有上述相位差时，第 ±2 阶光束可以用来按照改进的推挽方法检测跟踪误差信号，而第 ±1 阶光束可以用来按照三光束方法检测个跟踪误差信号。因而，可以选择性地改变跟踪伺服控制方法。

为了根据光盘 30 中形成的凹坑的深度通过检测上述衍射光束来执行最佳跟踪伺服控制，如图 6 所示，光检测装置 80 包括：接收第 0 阶光束的主光电检测器 81、接收第 ±1 阶光束的一对第一副光电检测器 83 和 85，和接收第 ±2 阶光束的一对第二副光电检测器 87 和 89。

主光电检测器 81 最好具有一个两部分结构，例如，四部分结构，以便可以用象散方法检测聚焦误差信号。第二副光电检测器 87 和 89 至少具有一个两部分结构，以便可以按改进的推挽方法检测跟踪误差信号。最好是，第二副光电检测器 87 和 89 具有用本发明的记录/再现设备再现 DVD-RAM 上记录的数据的四部分结构，如图 6 所示。当第二副光电检测器 87 和 89 具有四部分结构时，可以在再现 DVD-RAM 上记录的数据期间以改进的象散方法检测聚焦误差信号。

当主光电检测器的四个部分由 A、D、C 和 D 表示时，第二副光电检测器 87 和 89 每一个的四个部分分别由 E1、E2、E3 和 E4 以及 F1、F2、F3 和 F4 表示，并且由相同的参考标记表示其检测信号，当第一光电检测器 83 和 85 由 I 和 J 以及其检测信号由相同的参考标记表示时，三光束方法和改进的推挽方法中的跟踪误差信号 $TES_{3\text{-}BEAM}$ 和 TES_{DPP}，以及改进的象散方法（差分象散方法）中的聚焦误差信号 d-FES 用方程 1 表达。

[Equation 1]

$$TES_{3\text{-}BEAM}=I-L$$

$$TES_{DPP}=[(A+D)-(B+C)]-k[\{(E1+F1)+(E4+F4)\}-\{(E2+F2)+(E3+F3)\}]$$

$$d\text{-}FES=[(A+C)-(B+D)]-k'[\{(E1+F1)+(E3+F3)\}-\{(E2+F2)+(E4+F4)\}]$$

在这里，k是适用于第二副光电检测器87和89的检测信号的增益，以便可以用改进的推挽方法检测最佳跟踪误差信号。此外，k'是适用于第二副光电检测器87和89的检测信号的增益，以便可以用改进的象散方法检测最佳聚焦误差信号。在方程1中，来自相应部分和第一副光电检测器83和85的每个检测信号的标记表示从主光电检测器81、第二副光电检测器87、89和第一副光电检测器83和85的每个部分输出的电流信号或电流-电压转换的信号。

图7示出了光检测装置电路90和信号处理器100的结构。光检测装置电路90将主光电检测器和副光电检测器输出的电流信号转换成电压信号。参见附图，光检测装置电路90包括多个电流-电压（I/V）转换器91，用于将主光电检测器81和第一和第二副光电检测器83、85、87和89输出的电流信号转换成电压信号并输出该转换的信号。

从方程1中可以看出，在改进的推挽方法和改进的象散方法中，由于部分E1和F1、E2和F2、E3和F3、E4和F4中的每对的检测信号相加，因此光检测装置电路90最好这样构成：使从部分E1和F1、E2和F2、E3和F3、E4和F4中的每对输出的电流信号相加，并且由电流-电压转换器91将其转换成电压信号，如图7所示的那样。此外，由于在本发明的优选实施例的光记录/再现设备中选择性地使用了三光束方法和改进的推挽方法，因此，光检测装置电路90最好还包括一个开关95，用于选择性地输出第一副光电检测器83和85以及第二光电检测器87和89的检测信号。

当光检测装置电路90被构成图7所示的那样时，将有利于使光检测装置电路90的输出端子数量最小。

信号处理器100包括：第一检测部分101，用于采用改进的推挽方法从第0阶光束和第±2阶光束的检测信号中检测跟踪误差信号；和第二检测部分103，用于采用三光束方法从第±1阶光束的检测信号中检测跟踪误差信号。此外，信号处理器100最好包括控制器105，用于控制光检测装置电路90的开关95，以通过选择性地使用改进的推挽方法或三光束方法检测跟踪误差信号。控制器105通过使用光记录/再现设备检测的光盘类型信号控制开关95。

第一检测部分101包括第一至第三微分器101a、101b和101c，以及增益调节器102。第一微分器101a接收从接收第0阶光束的主光电检测器81

的四个部分 A、B、C 和 D 输出并被电流-电压转换的检测信号，并输出第一推挽信号。设置在对应于光盘 30 的正切方向（以下称为方向 T）的部分 A 和 D 的检测信号被输入到第一微分器 101a 的一个输入端子，而来自其它部分 B 和 C 的检测信号被输入到第一微分器 101a 的另一个输入端子。第二微分器 101b 接收从接收第 ±2 阶光束的第二副光电检测器 87 和 89 的四个部分 E1、E2、E3 和 E4 以及 F1、F2、F3 和 F4 输出并被电流-电压转换的检测信号，并输出第二推挽信号。设置在方向 T 的第二副光电检测器 87 和 89 的部分 E1、E4、F1 和 F4 的检测信号被输入到第二微分器 101b 的一个输入端子。第二副光电检测器 87 和 89 的其它部分 E2、E3、F2 和 F3 的检测信号被输入到第二微分器 101b 的另一个输入端子。第二推挽信号被增益调节器 102 放大预定的增益 k。第三微分器 101c 接收并微分第一推挽信号和被放大的第二推挽信号，并输出改进的推挽方法的跟踪误差信号 TES_{DPP}。这里，增益调节器 102 调节第二推挽信号的增益，以便可以最佳化改进的推挽方法的跟踪误差信号。增益调节器 102 的增益可以由控制器 105 控制。

第二检测部分 103 包括一个微分器 103a，用于接收和微分从接收第 0 阶光束的第一副光电检测器 83 和 85 输出并且被电流-电压转换的检测信号。微分器 103a 输出三光束方法的跟踪误差信号 $TES_{3\text{-}BEAM}$。

控制器 105 根据光盘的类型控制开关 95，以便使第一检测部分 101 在光盘 30 是能够至少记录一次或重复记录的预定光盘时，可以输出改进的推挽方法的跟踪误差信号 TES_{DPP}；以及使第二检测部分 103 在光盘 30 仅仅是用于再现的预定光盘时，可以输出三光束方法的跟踪误差信号 $TES_{3\text{-}BEAM}$；由此，根据本发明的优选实施例的光记录/再现设备可以根据光盘的类型以最佳方法实现跟踪伺服控制。

例如，当光盘 30 是 CD-ROM 时，控制器 105 操作光检测装置电路 90 的开关 95，使得来自第一副光电检测器 83 和 85 的检测信号输入到第二检测部分 103。因此，第二检测部分 103 输出三光束方法的跟踪误差信号。这里，第一检测部分不输出信号。

反之，当光盘 30 是例如 CD-R/RW 或 DVD-R/RW/RAM 时，控制器 105 操作开关 95，使来自主光电检测器 81 和第二副光电检测器 87 和 89 的检测信号被输入到第一检测部分 101。因此，第一检测部分 101 输出跟踪误差信号 TES_{DPP}。

这里，当光盘 30 是 DVD-ROM 时，还可以包括用于通过使用主光电检测器 81 的检测信号以差分相位检测方法检测跟踪误差信号的结构。

在根据本发明的优选实施例的记录/再现设备中，将第一光源发射的光束分解成主光束和至少四个对称于主光束的副光束，然后将分解的光束照射到光盘 30 上。光盘 30 反射的主光束和副光束被主光电检测器 81、第一副光电检测器 83 和 85 以及第二副光电检测器 87 和 89 检测，这些光电检测器可以采用三光束方法和改进的推挽方法同时检测跟踪误差信号。信号处理器 100 通过使用主光束和/或副光束的检测信号，根据光盘 30 的类型，以改进的推挽方法或三光束方法选择性地检测跟踪误差信号。这里，信号处理器 100 的控制器 105 根据光盘类型信号选择跟踪误差信号检测方法，并且操作光检测装置电路 90 的开关 95，以便可以用选择的方法检测跟踪误差信号。因而，对于能够至少记录一次或重复记录的光盘，第一检测部分 101 输出改进的推挽方法的跟踪误差信号 TES_{DPP}，而对于仅仅用于再现的光盘，第二检测部分 103 输出三光束方法的跟踪误差信号 $TES_{3\text{-}BEAM}$。

根据上述的本发明优选实施例的光记录/再现设备，通过根据光盘 30 的类型改变跟踪伺服控制方法可以实现最佳跟踪伺服控制。

尽管在上述优选实施例中，光检测装置电路 90 装备了开关 95，但本发明不限于此。也就是说，可以不用开关 95 构成光检测装置电路 90。在此情况下，为了改变跟踪伺服控制方法，信号处理器 100 最好还包括由控制器 105 控制的开关（未示出），设置在第一和第二检测部分 101 和 103 的输出端子或者在光检测装置电路 90 与第一和第二检测部分 101 与 103 之间。

此外，尽管已经说明本发明的光记录/再现设备包括：将第一光源 31 发射的光束分解成主光束和至少四个副光束的分光装置 40；以及具有一个相应的结构使跟踪误差信号可以用改进的推挽方法和三光束方法进行检测的光检测装置 80，但本发明不限于此。

也就是，可以将本发明的光记录/再现设备构成为：能够以推挽方法和三光束方法检测跟踪误差信号，在此情况下，用于将入射光束分解成第 0 阶光束和第 ±1 阶光束的衍射装置可以被设置为分光装置 40，使得第一光源 30 发射的光束被分解成主光束和至少两个副光束。

这里，如图 8 所示，光检测装置 180 具有与图 6 所示的光检测装置 80 相同的结构，其中省略了第二副光电检测器 87 和 89。本发明第二优选实施

例的信号处理器 110 的光检测装置电路 93，如图 9 所示，包括将主光电检测器 81 和第一副光电检测器 83 和 85 输出的电流信号转换为电压信号的电流-电压转换器 91。

此外，图 9 所示的信号处理器 110 包括：具有单个微分器的第一检测部分 111，以推挽方法从主光电检测器 81 的四个部分的检测信号中检测跟踪误差信号；和具有单个微分器的第二检测部分 113，以三光束方法从第一副光电检测器 83 和 85 的检测信号中检测跟踪误差信号。此外，信号处理器 110 最好包括安装在第一和第二检测部分 111 和 113 的输出端子的开关 117，和用于根据光盘类型控制开关 117 的控制器 115。因而，根据本发明的另一个优选实施例的光记录/再现设备可以根据光盘类型选择跟踪伺服控制方法。这里，开关 117 可以安装在光检测装置电路 93 与第一及第二检测部分 111 及 113 之间。

当根据本发明另一个优选实施例的光记录/再现设备包括光检测装置 180、光检测装置电路 93 和信号处理器 110 时，三光束方法和推挽方法的跟踪误差信号 $TES_{3\text{-}BEAM}$ 和 TES_{PP} 在方程 2 中示出。

[Equations 2]

$$TES_{3\text{-}BEAM}=I-J$$

$$TES_{PP}=[(A+D)-(B+C)]$$

下面将结合图 4 说明本发明的光记录/再现设备中采用的光拾取器的一个例子。

第一光源 31 发射具有适合于记录和/或再现 CD 族光盘上的数据的 780nm（纳米）波长的光束。如图 4 所示的光学系统包括第一光径改变装置 53，例如，立方型分光器；和物镜 61，用于聚集由分光装置 40 分光的主光束和副光束并且将聚集的光束聚焦到光盘 30 上。光学系统还可以包括第一准直透镜 59，使平行光束输入到物镜 61。

光拾取器最好还包括第二光源 71，用于发射具有例如 650nm 波长的光束，以便可以适合地应用具有其厚度不同于 CD 族光盘厚度的 DVD 族光盘。这里，光学系统还包括第二光径改变装置 75，例如，平面型分光器，用于改变从第二光源 71 发射的光束的光径。

第一准直透镜 59 最好被安排在物镜 61 与第一光径改变装置 53 之间，以便准直从第一和第二光源 31 和 71 发射的光束。

同时，为了改善从第一光源 31 发射并到达光盘 30 的光束的效率，光拾取器最好还包括沿第一光源 31 与第一光径改变装置 53 之间的光径设置的第二准直透镜 51。当沿着第一光源 31 发射的光束的光径插入第二准直透镜 51 时，由于可以将准直透镜的整个系统的焦距做得很短，并且不需要改变关于第一光源 31 发射的光束的其它光学系统的配置结构，因此，可以进一步改善从光盘 30 发射的光束的效率。例如，当第一准直透镜 59 的焦距是 25mm（毫米）时，通过插入具有 13mm 焦距的第二准直透镜 51 可以将准直系统的总焦距减至 12.5mm。因而，从第一光源 31 发射的并照射到光盘 30 上的光束的效率可以被改善，以致当光盘 30 是诸如 CD-RW 的可重写光盘时，可以有效地将信息记录到光盘 30 上。

在第二光源 71 与第二光径改变装置 75 之间还设置了将第二光源 71 发射的光束衍射成第 0 阶光束和第 ±1 阶光束的光栅 73，以便在再现记录在 DVD 族光盘上的数据期间采用改进的象散方法执行聚焦伺服控制。

在图 4 中，参考标号 55 代表前光电检测器，用于选择性地监视第一和第二光源 31 和 71 的输出；参考标号 57 代表反射镜；参考标号 63 代表设置在物镜 61 与光检测装置 80 之间的调节透镜。调节透镜 63 通过调节输入到光接收部分的光束的象散进行聚焦误差信号检测。

利用了具有图 4 所示光结构的光拾取器的本发明的光记录/再现设备可以在再现记录在 CD-族光盘上的数据期间根据 CD-族光盘类型实现光跟踪伺服控制。此外，本发明的光记录/再现设备可以用第一和第二光源 31 和 71 发射的光束再现 CD-族和 DVD-族光盘上记录的信息，并且当光盘 30 是诸如 CD-RW 的可重写光盘时，可以用第一光源 31 发射的光束将信息记录在光盘 30 上。

这里，当光栅 73 被构成充当分光装置 40 时，本发明的光记录/再现设备可以在再现记录在 DVD 族光盘上的数据期间，实现最佳跟踪伺服控制。

尽管本发明的光记录／再现设备的光检测装置电路和信号处理器是按照图 7 和图 9 的配置描述的，但它们并不局限于此，而是可以在本发明的技术概念范围内以各种方式进行修改。

此外，图 4 所示的光拾取器的光学配置仅仅是一个实例，本发明不局限于这样一种光学配置。例如，根据采用具有 780nm 或 650nm 波长的单光源的光拾取器的本发明的光记录/再现设备可以适用于记录和／或再现诸如 CD-

RW驱动的CD族光盘上的数据的设备，或者记录和／再现诸如DVD-RAM驱动的DVD族光盘上的数据的设备。

此外，被配置为使第一光源31发射具有650nm波长的光束和使第二光源71发射具有780nm波长的光束的本发明的光记录/再现设备，根据DVD族光盘的类型，在从DVD族光盘再现数据期间实现光跟踪伺服控制。此外，本发明的光记录／再现设备可适用于用第一和第二光源31和71发射的光再现记录在DVD族和CD族光盘上的信息的设备，和／或用第一光源31发射的光将信息记录在诸如DVD-R/RW/RAM的可记录光盘上的设备。

如上所述，在根据本发明的光记录/再现设备中，由于能够根据光盘类型选择性地使用改进的推挽方法及推挽方法和三光束方法中的一种的伺服控制方法，因此，在再现来自非可重写光盘的数据期间可以实现最佳跟踪伺服控制，而不用考虑光盘凹坑的深度。

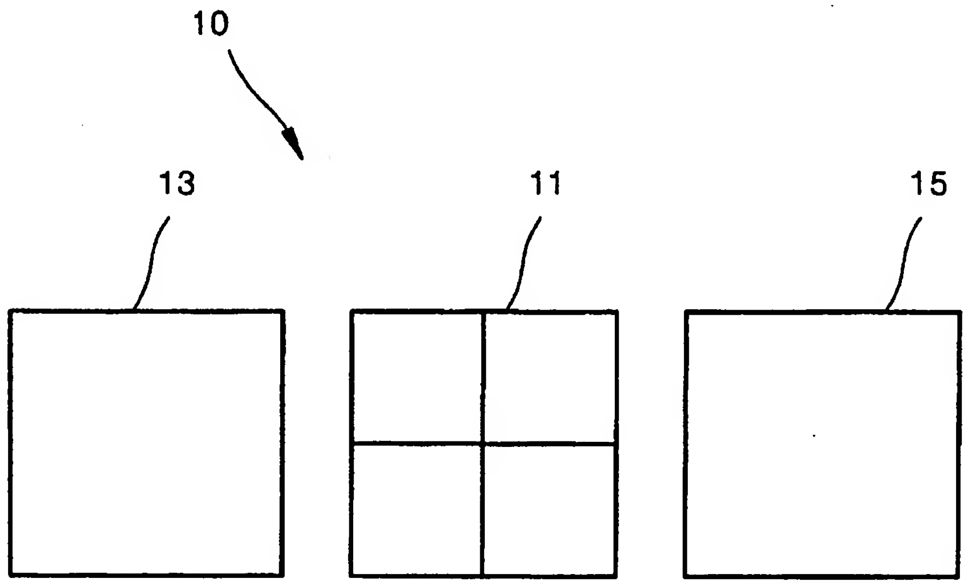


图 1

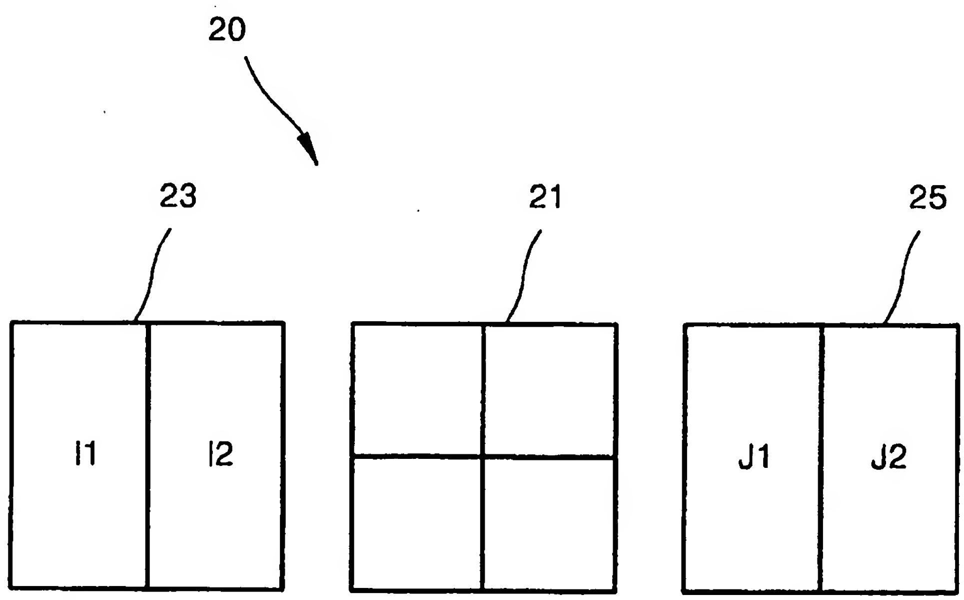


图 2

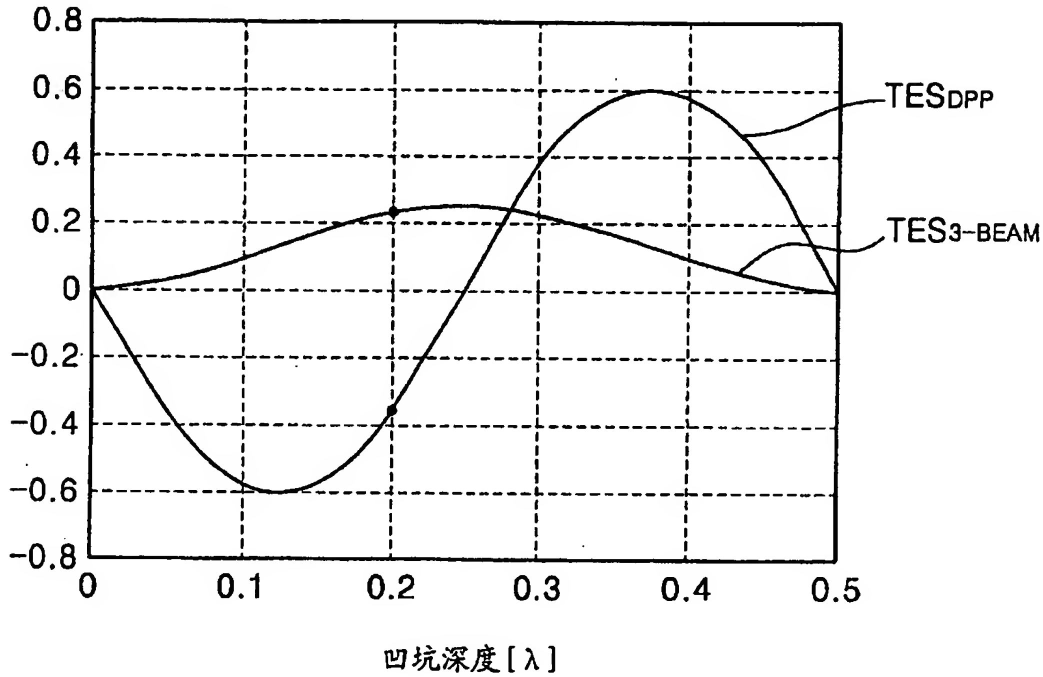


图 3

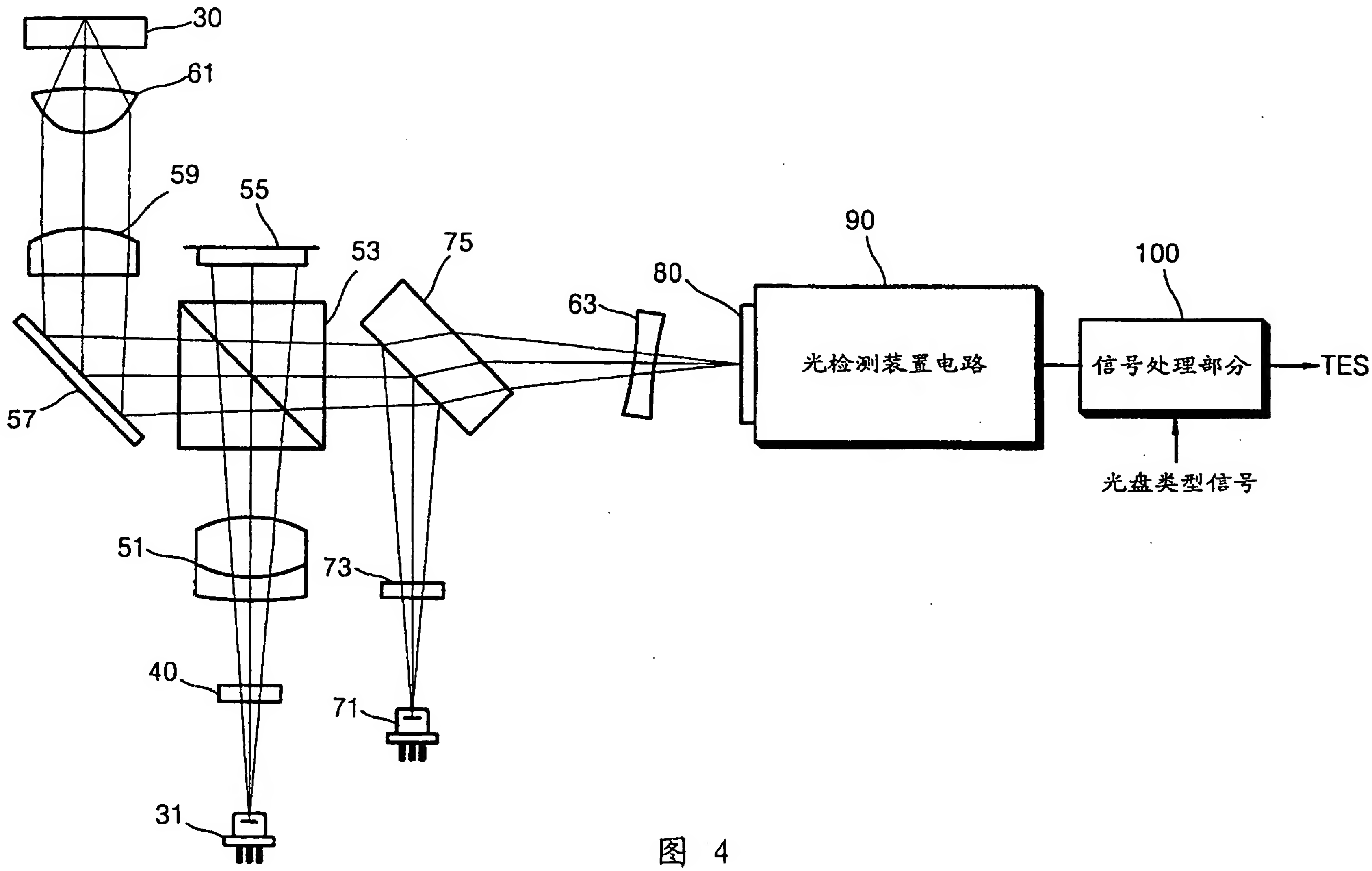
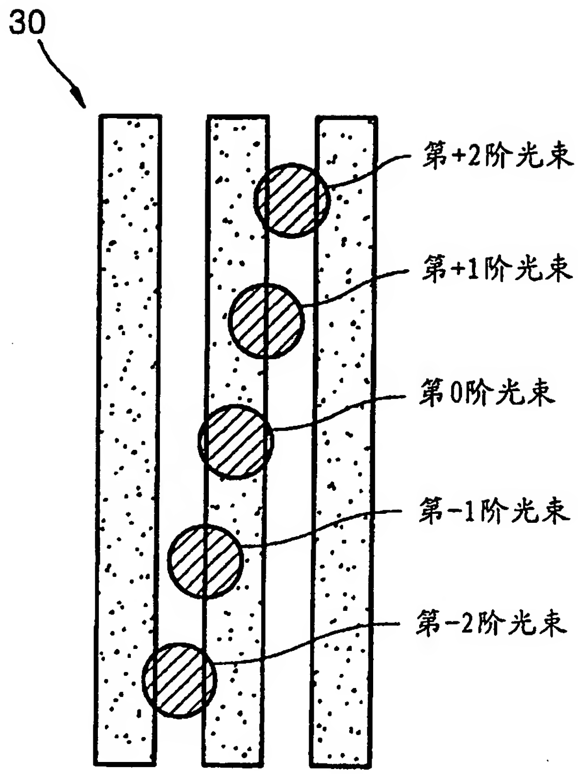
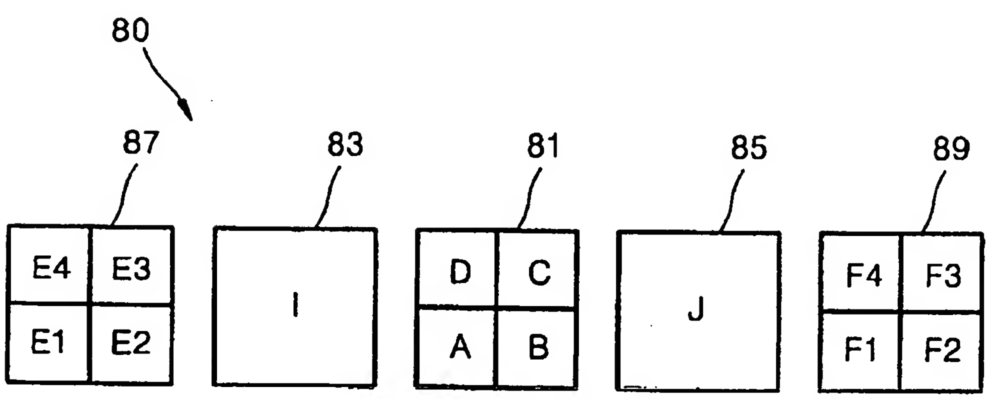

30
61
59
55
53
75
80
90
100
63
57
光检测装置电路
信号处理部分
TES
光盘类型信号
51
73
40
71
31

图 4



30
第+2阶光束
第+1阶光束
第0阶光束
第-1阶光束
第-2阶光束

图 5



80
87
83
81
85
89
E4
E3
E1
E2
I
D
C
A
B
J
F4
F3
F1
F2

图 6

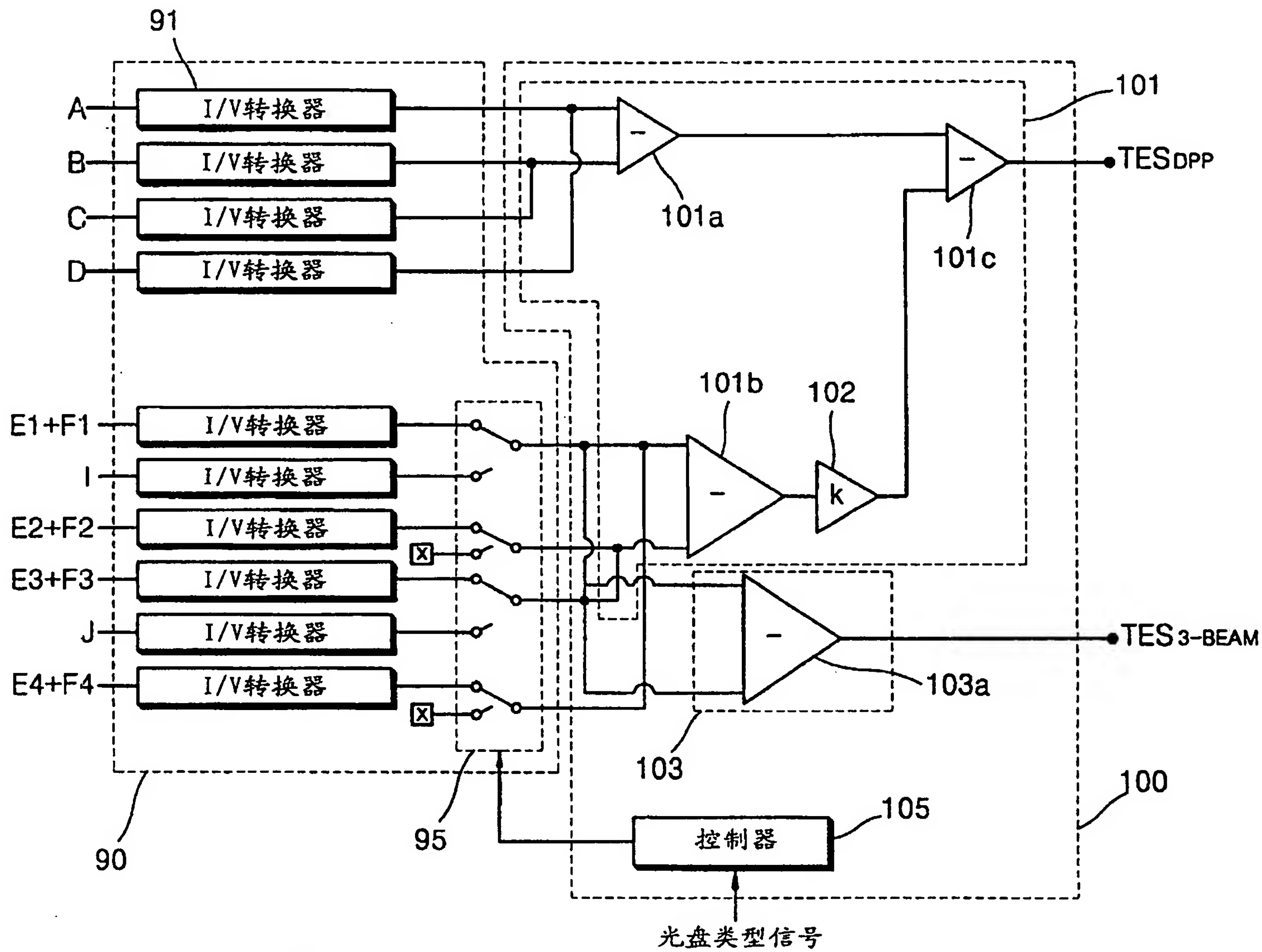

91
A
B
C
D
I/V转换器
I/V转换器
I/V转换器
I/V转换器
E1+F1
I
E2+F2
E3+F3
J
E4+F4
I/V转换器
I/V转换器
I/V转换器
I/V转换器
I/V转换器
I/V转换器
101
TESDPP
101a
101c
101b
102
k
TES3-BEAM
103a
103
100
105
控制器
90
95
光盘类型信号

图 7

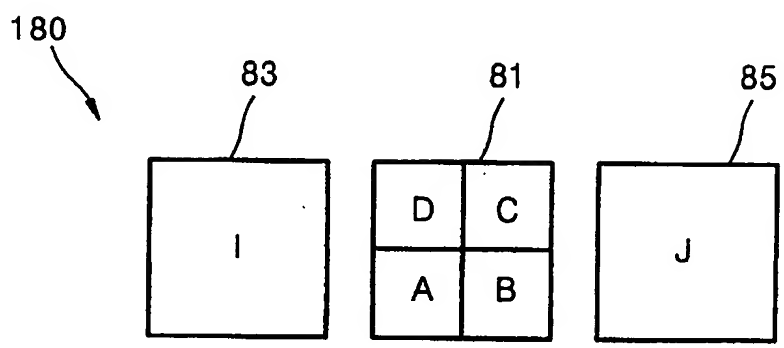

180
83
81
85
I
D
C
A
B
J

图 8

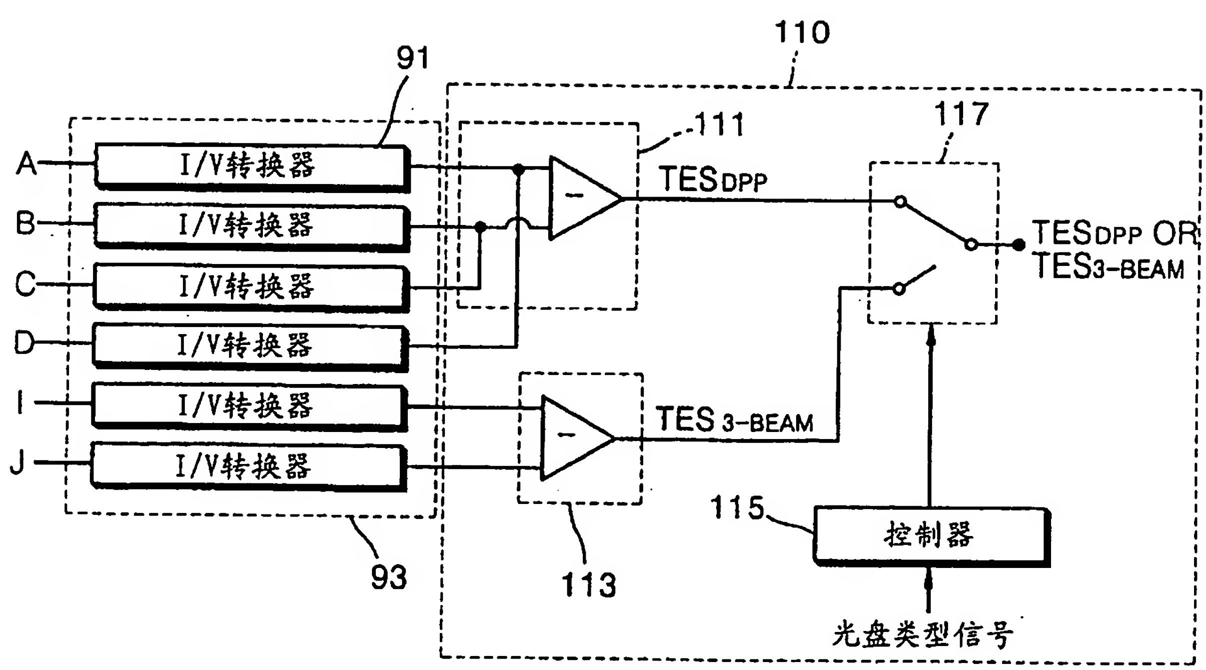

110
91
111
117
A
B
C
D
I
J
I/V转换器
I/V转换器
I/V转换器
I/V转换器
I/V转换器
I/V转换器
TESDPP
TESDPP OR
TES3-BEAM
TES 3-BEAM
115
控制器
93
113
光盘类型信号

图 9